

FTA GRANT NO. MA-03-0292 FITCHBURG LINE

CONTRACT SPECIFICATIONS for MBTA Contract No. G67CN01

FITCHBURG COMMUTER RAIL LINE IMPROVEMENTS PROJECT

SOUTH ACTON STATION ACTON, MASSACHUSETTS

June, 2012 VOLUME 2 OF 2

HNTB CORPORATION 300 APOLLO DRIVE CHELMSFORD, MA 01824

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APPENDIX A

GUIDELINES AND PROCEDURES FOR CONSTRUCTION ON MBTA RAILROAD PROPERTY



RAILROAD OPERATIONS DIRECTORATE

The attached Specifications are required for any construction and/or related activities on, over, under, within or adjacent to railroad property owned or controlled by the Massachusetts Bay Transportation Authority. They are intended to provide general guidelines and safeguards. Attachment "A" of Construction Guidelines and Procedures contains a summary of MBTA Railroad Operations Specifications which may be required. It is the responsibility of the Contractor to obtain all the necessary specifications for each project.

MAY 1994



RAILROAD OPERATIONS DIRECTORATE

GUIDELINES AND PROCEDURES

FOR CONSTRUCTION ON

MBTA RAILROAD PROPERTY

APRIL 2001

SECTION 1. SCOPE

1.01 These specifications provide general safeguards to railroad property owned or controlled by the Massachusetts Bay Transportation Authority and to railroad operations upon that property during the performance of construction and/or related activities on, over, under, within or adjacent to the railroad property. They are intended as guidelines and do not represent all legal requirements which are or may be associated with construction and/or related activities. The MBTA reserves the right to require additional information and clarification and to make unilateral changes to these specifications at any time, at its sole discretion.

SECTION 2. DEFINITIONS

MBTA

Massachusetts Bay Transportation Authority

TRA

Transit Realty Associates, LLC, Designated Representative of MBTA Real Estate

RAILROAD COMPANY

The particular reference for the purpose of these specifications is the railroad company which maintains and/or operates or has trackage rights on the subject MBTA Railroad Property, including, but not limited to:

- -Massachusetts Bay Transportation Authority ("MBTA")
- -Providence and Worcester Railroad ("P&W")
- -National Railroad Passenger Corporation ("Amtrak")
- -CSX Transportation ("CSX")
- -The Boston and Maine Corporation, The Springfield Terminal Railway Company, its affiliates, successors and assigns ("B&M")
- -Bay Colony Railroad Corporation ("Bay Colony")

MBTA RAILROAD PROPERTY

All railroad rights of way and adjacent owned and/or controlled by the MBTA.

OWNER

The individual, utility, government, or corporation having title to the structure to be constructed upon, over or adjacent to railroad property owned or controlled by the MBTA.

UTILITY

Public or private communication, water, sewer, electric, gas and petroleum companies or other entity governed by the Massachusetts Department of Public Utilities.

GOVERNMENT

Federal, State, Town, City, County and other forms of government.

CORPORATION

Any firm duly incorporated under laws of a state government.

INDIVIDUAL

Any party not defined by "Owner, Utility, Government or Corporation".

CONTRACTOR

The individual, partnership, firm, corporation or any combination thereof, or joint venture, contracting with a Utility. Government, Firm, Company, Corporation or Individual for work to be done on, over, under, within or adjacent to MBTA Railroad Property.

OWNER OR ITS CONTRACTOR

As used in these specifications, does not affect the responsibilities of either party for work conducted on, over, under, within or adjacent to MBTA Railroad Property.

SECTION 3. SUBMITTALS

3.01 INITIAL CONTACT

- A. The MBTA owns the majority of the railroad lines in eastern Massachusetts. Many of these railroad lines are operated for passenger service, using a Railroad Company as an operating and maintaining contractor. Some of the railroad lines are used for freight-only service, operated and maintained by other Railroad Company(s). In most instances, both passenger and freight service are operated over the same railroad lines.
- B. All of the MBTA railroad lines are maintained by a designated Railroad Company(s), excepting rapid transit and light rail lines. The maintaining Railroad Company(s) has rights and responsibilities, in addition to the MBTA's property owner's rights.
- C. To obtain further information concerning License Agreements, Easements, Licenses for Entry, and performance of construction related activities which affect MBTA Railroad Property, a written request may be forwarded to:

License Administrator

Transit Realty Associates, LLC 20 Winthrop Square Boston, MA 02110

or you may access the website at www.transitrealty.com.

The License Administrator is also the contact person for information concerning rapid transit and light rail lines.

SECTION 4. PLANS AND SPECIFICATIONS

- 4.01 SCOPE: It is the intent of the MBTA to eliminate or minimize any risk involved with construction or related activities on, over, under, within or adjacent to MBTA Railroad Property. Therefore, MBTA approval and frequently one or more Railroad Company(s) approval of construction plans and specifications for all phases of a proposed project affecting MBTA Railroad Property is required.
- 4.02 GENERAL: The applicant must provide six (6) sets of plans and specifications to the License Administrator. These plans and specifications must meet the approval of the Railroad Company(s) and the MBTA prior to the start of construction. These plans are to be prepared in sizes as small as possible and are to be folded to an 8-1/2 inch by 11 inch size (folded dimensions) with a 1-1/2 inch margin on the left side and a 1 inch margin on the top.
 - A. After folding, the title block and other identification of the plans shall be visible at the lower right corner, without the necessity of unfolding. Each plan shall bear an individually identifying number and an original date, together with subsequent revision dates, clearly identified on the plan.
 - B. All plans are to be individually folded or rolled and where more than one plan is involved, they shall be assembled into complete sets before submission to the MBTA.
- 4.03 PLANS: The plans are to show all the work which may affect MBTA Railroad Property, and contain a location map and plan view of the project, with appropriate cross sections and sufficient details. The proposed construction or related activities must be (orated with respect to top of rail (vertical) and center line of track (horizontal). The plan must also include railroad stationing, property lines and subsurface soil conditions. The subsurface information is to be in the form of boring logs with the borings located on the plan view. The plans must be stamped by a Professional Engineer registered in the state of Massachusetts. (The purchase of railroad valuation plans may be arranged by contacting MBTA Engineering offices at 222-6179).
- 4.04 SPECIFICATIONS: The specifications summarized on Attachment "A" attached hereto are the Standard Specifications of the MBTA Railroad Operations

Department and apply to all types of construction work affecting MBTA Railroad Property.

A. In addition to "Maintenance and Protection of Railroad Traffic" and "Insurance Specifications" which are required for all work on, over, under, within or adjacent to MBTA Railroad Property, certain other Specifications contained in Attachment "A" shall be incorporated into construction/engineering submittals when deemed necessary by the MBTA and/or Railroad Company(s). (The purchase of additional specifications may be arranged by contacting MBTA offices at 222-3448 or visiting TRA website at www.transitrealty.com).

SECTION 5. <u>SUBMISSION REVIEW</u>

- 5.01 An initial submission of six (6) sets of plans and specifications for MBTA review must be forwarded to the License Administrator, along with a completed MBTA Application for Entry (Attachment "E"). The submission will be circulated for review and comment to MBTA departments which may be impacted by the proposed project. If approved by the MBTA, the Railroad Company(s) will review.
- 5.02 The applicant is advised that the MBTA's initial review process requires a minimum forty-five (45) day period, prior to the Railroad Company(s) involvement, and additional processing time may be required for specific documents (See Section 9).

SECTION 6. <u>INSPECTIONS/PAYMENTS</u>

- 6.01 The MBTA may inspect all projects affecting MBTA Railroad Property at least twice, at the applicant's sole expense. The actual number of MBTA inspections will depend on the size and complexity of the project.
- 6.02 The MBTA may utilize Railroad Company inspectors and flagmen for daily inspection and protection of rail traffic during the term of the construction period or related activities. The Owner or Contractor will be responsible for advance payment of all associated fees.
- 6.03 Advance payments to the MBTA for construction/engineering review of plans and specifications by MBTA staff must be submitted when initial contact is made with the License Administrator. Payments shall be in the form of check or money order, made payable to the Massachusetts Bay Transportation Authority.
- 6.04 Advance payments covering the services for Railroad Company(s) construction/engineering review of plans and specifications, or services of an inspector or flagman, will be paid <u>directly to the Railroad Company(s)</u>. The MBTA will advise when such services are required, and the Railroad Company(s) will advise of the amount of the required advance payment.

SECTION 7. EXAMINATION OF PLANS OR PROPERTY

7.01 The Contractor/Applicant shall have no claim for any differences between MBTA valuation plans and the actual conditions encountered in the field.

SECTION 8. INSURANCE AND INDEMNIFICATION

- 8.0I Prior to entry upon MBTA Railroad Property, insurance will be provided to and approved by the MBTA and affected Railroad Company(s), as outlined in "Insurance Specifications."
- 8.02 Additionally, all MBTA Licenses and Letters of Authorization contain a clause for Indemnifying MBTA and the Railroad Company(s) from and against any and all liabilities, losses, damages, costs, expenses, causes of action, suits, claims, demands and/or judgments of any nature whatsoever that may be imposed upon or incurred by or asserted against the MBTA or the Railroad Company(s).

SECTION 9. <u>LEGAL DOCUMENTS FOR TEMPORARY AND PERMANENT INSTALLATIONS</u>

- 9.01 The nature of entry upon or installation within MBTA Railroad Property will determine the authorizing document to be issued. Listed below are brief descriptions of MBTA documents:
 - A. <u>License for Entry</u>: Authorizes short-term entry for purposes of survey, Inspection, test borings, access, etc. One time administrative/ engineering/legal review and access fees.
 - **B.** <u>License Agreement</u>: Authorizes installations, subject to termination clause, if Applicant chooses not to pursue an Easement. One time administrative/engineering/legal review fee as well as annual rental fee.
 - **C.** <u>Easement</u>: Authorizes permanent installations in form suitable for recording at Registry Deeds. All easements are non-exclusive and subject to relocation at the Owner's expense, for Mass transportation purposes:
 - Easements must receive MBTA Board of Directors approval, which involves considerable time. Once approved by the Board of Directors and upon payment in full to the MBTA, a License for Construction is issued. Upon final inspection and acceptance of the installation by the MBTA the Easement document is issued.
 - 2. Permanent Subsurface Easement widths are limited to a maximum three-foot distance on either side of the occupation.

- 3. a) A one-time administrative/engineering/legal review fee, in addition to value of easement, as established by independent appraisal conducted at the Applicant's expense.
 - b) If easement size is minimal, as determined by the MBTA, a fixed fee, encompassing administrative/engineering/legal review fee.
- **D.** <u>Letter of Authorization</u>: Authorizes installations and construction activities in association with Master License Agreements. One-time administrative/engineering/legal review as well as access and/or annual fees.

ATTACHMENT "A"

SUMMARY OF MBTA RAILROAD OPERATIONS SPECIFICATIONS

I. <u>GUIDELINES AND PROCEDURES FOR CONSTRUCTION ON MBTA</u> RAILROAD PROPERTY

This general specification outlines the immediate design requirements and methodology for progressing construction activities on MBTA Railroad Property.

II. MAINTENANCE AND PROTECTION OF RAILROAD TRAFFIC

This specification will be included in ALL work requirements on MBTA Railroad Property, and covers rules, requirements, and protective services or any construction-related activity on MBTA Railroad Property. Supplemental specifications are listed below.

III. INSURANCE SPECIFICATIONS

This specification details required insurance coverages and limits of the MBTA and Railroad Company(s).

IV. PIPELINE OCCUPANCY SPECIFICATIONS

This specification details requirements for all pipeline borings/jackings and open cuts on or adjacent to MBTA Railroad Property, as well as requirements for plan submittals.

V. SPECIFICATIONS FOR WIRE CONDUIT AND CABLE OCCUPATIONS

This specification details requirements for clearances and installations of parallel and overhead crossings on MBTA Railroad Property, as well as requirements for plan submittals.

VI. BRIDGE ERECTION DEMOLITION AND HOISTING OPERATIONS

This specification details plan preparation for demolition and/or hoisting and erection of structures on and over MBTA Railroad Property.

VII. TEMPORARY SHEETING AND SHORING

This specification details requirements for plan preparation and calculations necessary for sheeting and shoring for construction on or adjacent to MBTA Railroad Property.

VIII. BLASTING SPECIFICATIONS

This specification outlines submittals, details and requirements for blasting on or adjacent to MBTA Railroad Property.

IX. TEMPORARY PROTECTION SHIELDS FOR DEMOLITION AND CONSTRUCTION

This specification outlines criteria for plan preparation related to protection of MBTA Railroad Property when work takes place on overhead structures.

X. INDUSTRIAL SIDE TRACK SPECIFICATIONS

This specification outlines minimal requirements for materials and installation submission for private railroad side tracks up to MBTA property line and/or clearance point. Other provisions, site-specific, may be required, including signal protection maintenance and protection of railroad traffic.

XI. RIGHT OF WAY FENCING SPECIFICATIONS

This specification details the requirements for the materials, construction and installation of standard right of way fence.

XII. TEST BORING SPECIFICATIONS

This specification outlines procedures and requirements for the performance of test borings on MBTA Railroad Property.

XIII. FIBER OPTIC CABLE SPECIFICATIONS

This specification details requirements for design and installation of fiber optic cables on MBTA Railroad Property; and is modified by site-specific requirements, including the construction methodology, location and type of fiber optic cables and protection conduits.

XIV. RAILROAD OPERATIONS BOOK OF STANDARD PLANS, TRACK AND ROADWAY, MW-I SPECIFICATIONS FOR CONSTRUCTION AND MAINTENANCE OF TRACK

Certain construction activities may require obtaining this comprehensive package if rail construction details and requirements are related to the track operation.

XV. COMMUTER RAIL DESIGN STANDARDS

ATTACHMENT "B"

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY APPLICATION FOR ENTRY UPON MBTA RAILROAD PROPERTY \$500.00 Administrative Fee must be submitted with Application

	Type of Entity (Partnership, Corporation, Proprietorship, Public Authority, etc.):
	Mailing Address:
	If incorporated, state of incorporation:
	Proposed license term commencement date:
	Proposed license term:
	Agents for applicant for service of notice or process:
	If applicant is self-insured, please provide limits of self-insurance and attach copies of authorizing legislation or certification thereof:
	If applicant is authorized by public authority to enter into such license agreement, ple provide:
	Motion, Resolution, or Ordinance No.:
	Date of Adoption:
	Adopted by:
•	Name and title of applicant's officer authorized to sign agreement:

Project Description

1.	Brief description of construction (including types of pipes and other attachments or anc facilities to be installed on MBTA Railroad Property):	illary
2.	Brief description of purpose of entry and/or installation:	

Space Requirements [To Be Provided]

Technical Information

1.		this occupancy within the limits of a public road?		
	Att	ach copies of applicant's franchise to occupy such space.		
2.	. If occupancy is under, over, through, or attached to undergrade or overhead bridge, such bridge?			
3.		pe of occupancy (facility): Exact Length of MBTA Railroad Property to be burdened by occupancy:		
	b)	Width of excavation facility on MBTA Railroad Property:		
	c)	Number of manholes:		
	A.	Aerial or underground wire and cable:		
		(1) Telephone and other communication cables:		
		Number of cables:		
		Number of pairs/cable:		
		Are these composite coaxial cables?		
		(2) Power Cables:		
		Number of cables/size:		
		Number of volts per conductor:		
		Are these pipe-type cables consisting of one or more high voltage ca encased in steel pipe under inert oil pressure?	bles	
		(3) Fiber optic cables:		
		Number of cables:		
		Number of distribution cables:		
		Number of transmission cables:		
		Number of strands in each cable:		

	Number	of repeater stations on MBTA Railroad Property:
	Systems	s (check one):
	Trar	nsmission
	Dist	ribution
	Sen	sor
	(4) Number	of spare or unoccupied ducts to be installed:
В.	Pipes and Sew	/ers
	(1) Circular	line carrying no pressure:
	Number	of pipes:
	Number	of inches of inside nominal diameter per pipe:
	` '	lines under pressure and carrying non-flammable, non-explosive, or nbustible supporting materials, except coal and slurry:
	Number	of pipes:
	Number	of inches of inside nominal diameter per pipe:
	` '	lines under pressure and carrying flammable, explosive, or combustible ing material:
	Number	of pipes:
	Number	of inches of inside nominal diameter per pipe:
	(4) Non-circ	cular pipe:
	(5) Will a pi	pe tunnel be constructed?
	(6) Will pipe	e be supported by MBTA structures, bridges, etc.?
	Explain:	·
	(7) Will pipe	e be attached to MBTA structures, bridges, etc.?
	Explain:	

Number of wooden poles to be installed on MBTA Railroad Property: Other wooden supporting structures: Steel supporting structures: Number of braces, stub poles: Number of guy wires anchored on MBTA Railroad Property: _____ Number of span guy wires crossing MBTA Railroad Property: _____ D. Attachments (1) Attachment of aerial wires and cables to poles or other structures of MBTA used in wire line construction or support: Number of wires attached to MBTA cross-arm: Voltage of wire: Number of wires attached to applicant's cross-arm or bracket: ____ Voltage of wire: Number of cross-arms or brackets attached to MBTA poles: _____ (2) Attachment of aerial wires and cables to building or structures other than those used in wire line construction or support: Number of wires or cables attached to MBTA's building or structures: (3) Attachment of cable terminals to poles, buildings, or structures including highway bridges, railroad bridges over highways, or other bridges of MBTA: Number of cable terminals, loading coils, transformers, or like devices attached: Explain:

C.

Ancillary Facilities

E. Guy wire crossings and overhanging cross-arms and power wires of pole lines

outside MBTA right-of-way.

	• • • • • • • • • • • • • • • • • • • •	IBTA Railroad property but not anch	ored
		ging MBTA Railroad Property from p	oles located
	Number of cross-arms on any p	oles:	
associated with M	BTA's preliminary and final engine charges in excess of the initial actions.	signed applicant will bear any and al neering review in connection with thi dvance payment will be billed directly	s
	Agent: _		
	For:		
		Name of Applicant	
	By: _	(Title)	
	-	(Date)	

ATTACHMENT "C"

REFERENCED STANDARDS AND SPECIFICATIONS

- A. Wherever standards or specifications issued by a recognized industry association or regulatory body are referenced in these Specifications, the reference shall be interpreted as incorporating the referenced standard or specification in total into these Specifications as applicable. In the event of a difference between referenced standard or specifications and these Specifications, the latter shall govern.
- B. Technical Reference Abbreviations References are made to recognized standards by use of the acronyms listed below. Addresses are included for convenience, and the accuracy of the addresses is not warranted:

AA The Aluminum Association

900 19th Street NW Washington, DC 20006

AAR The Association of American Railroads

American Railroads Building

50 F Street NW

Washington, DC 20001

AASHTO American Association of State Highway and

Transportation Officials
444 North Capitol Street NW

Suite 249

Washington, DC 20001

ACGIH American Conference of Governmental Industrial

Hygienists

1330 Kemper Meadow Drive

Cincinnati, OH 45240

ACI American Concrete Institute

P. O. Box 19150 Detroit, MI 48219

AFPA American Forest and Paper Association

1111 19th Street, NW

Suite 700

Washington, DC 20036

AIA American Insurance Association

1130 Connecticut Avenue NW

Washington, DC 20036

AISC American Institute of Steel Construction Inc.

1 East Wacker Drive

Suite 1300

Chicago, IL 60601

AISI American Iron and Steel Institute

1101 17th Street NW

Suite 1300

Washington, DC 20036-4700

AITC American Institute of Timber Construction

7012 South Revere Parkway

Suite 140

Englewood, CO 80112

ANSI American National Standards Institute

11 West 42nd Street New York, NY 10036

APA American Plywood Association

P. O. Box 11700 Tacoma, WA 98411

APHA American Public Health Association

1015 15th Street NW Washington, DC 20005

AREA American Railway Engineering Association

50 F Street NW

Washington, DC 20001

ASCE American Society of Civil Engineers

345 East 47th Street New York, NY 10017

ASHRAE American Society of Heating, Refrigerating and

Air Conditioning Engineers 1791 Tullie Circle, NE Atlanta, GA 30329 ASME American Society of Mechanical Engineers

345 East 47th Street New York, NY 10017

ASTM American Society for Testing and Materials

1916 Race Street Philadelphia, PA 19103

AWPA American Wood Preservers' Association

P. O. Box 286

Woodstock, MD 21163-0286

AWS American Welding Society

550 NW 42nd Avenue Miami, FL 33126

AWWA American Water Works Association, Inc.

6666 W. Quincy Avenue Denver, CO 802350

CSI Construction Specifications Institute

601 Madison Avenue

Alexandria, VA 22314-1791

FHA Federal Highway Administration

400 7th Street SW

Washington, DC 20590

FRA Federal Railroad Administration

403 7th Street SW Washington, DC 20590

ICBO International Conference of Building Officials

5360 Workman Mill Road

Whittler, CA 90601

IIA Incinerator Institute of America

60 East 42nd Street New York, NY 10017



RAILROAD OPERATIONS DIRECTORATE

MAINTENANCE AND PROTECTION OF RAILROAD TRAFFIC

APRIL 2001

SECTION I. GENERAL

- 1.01 The contractor should note that these specifications govern proposed work that involves construction on, over, under, within or adjacent to MBTA Railroad Property. Requirements must be strictly observed whenever the tracks, structures, or properties of the MBTA are involved or affected.
- 1.02 If the tracks or other facilities of the MBTA are endangered, the Contractor shall immediately perform such work as directed by the Railroad Company(s), and upon failure of the Contractor to carry out such orders immediately, the Railroad Company(s) may take whatever steps are necessary to restore safe conditions. The cost and expense to the Railroad Company(s) and/or MBTA of restoring safe conditions or of any damage to the MBTA's trains, tracks, or other facilities caused by the Contractors' or subcontractors' operations, shall be at the sole expense of the Contractor and will be collected as appropriate. This cost shall be paid for by the Contractor and may be deducted from any monies due and that may become due to the Contractor.
- 1.03 Before entering upon MBTA Railroad Property:
 - A. The Owner or its Contractor shall be fully informed of all requirements of the MBTA pertaining to the specific project and shall conduct all his work accordingly. Any questions relating to the requirements of the MBTA should be directed to the Chief Engineering Officer of the MBTA or his authorized representative.
 - B. The Owner or its Contractor shall execute an MBTA License for Entry, and shall provide the MBTA and Railroad Company(s) with the information required in the "Insurance Specifications".
 - C. The Owner or its Contractor shall take note that if an excavation is to be made within a 2 to 1 slope line commencing 5.5 feet from the centerline of track, he shall submit the proposed method of soil stabilization for approval by the Chief Engineering Officer of the MBTA.
 - D. The Owner or its Contractor shall furnish detailed plans for falsework, bracing, sheeting, or other supports adjacent to the tracks for approval by the Chief Engineering Officer of the MBTA and the Railroad Company(s), and the work shall be performed in accordance with temporary "Sheeting and Shoring". All plans and calculations shall be stamped by a Registered Professional Engineer.
 - E. The Owner or its Contractor shall give written notice to the Chief Engineering Officer of the MBTA and the applicable Railroad Company(s) at least 21 days in advance of starting work or locating equipment at the site.
 - F. The Owner or its Contractor shall make all necessary arrangements with the

MBTA before entering upon MBTA Railroad Property.

1.04 After entering upon MBTA Railroad Property:

- A. The Owner or its Contractor shall have, in his possession on the job site, the contract plans and specifications which bear the stamp of approval of the MBTA Chief Engineering Officer or Railroad Company(s). The Owner or its Contractor shall conduct all his work according to these plans and specifications.
- B. All work shall be performed and completed in a manner fully satisfactory to the MBTA Chief Engineering Officer or authorized representative(s). Railroad Company(s) inspection of the work shall be conducted at any time and the Owner or its Contractor shall cooperate fully with the MBTA and Railroad Company(s) representatives.
- C. All equipment used by the Owner or its Contractor on MBTA Railroad Property may be inspected by the Railroad Company(s) and shall not be used if considered unsatisfactory by the Railroad Company(s) representative. Equipment of the Owner or its Contractor to be used adjacent to tracks shall be in first class condition so as to positively prevent any failure that would cause delay in the operation of trains or damage to MBTA or railroad facilities. Equipment shall not be placed or put into operation adjacent to a track without first obtaining the permission of the Railroad Company(s).
- D. Operators of such equipment must be properly licensed and may be examined by the Railroad Company(s) representative to determine their fitness. If it is determined that they are unfit to work, then the Owner or its Contractor shall remove them from MBTA Railroad Property.
- E. If the Chief Engineering Officer of the MBTA deems it necessary, the Owner or its Contractor shall furnish and erect in close proximity to the site of the work a suitable, furnished shelter with lights, heat, telephone, etc., for use by Railroad Company(s) personnel providing services to the Owner's or Contractor's work.
- F. The Owner or its Contractor's work shall be performed in such manner that the tracks, train operations and appurtenances of the MBTA and the Railroad Company(s) will be safeguarded.
- G. Open excavations shall be suitably planked and safeguarded when construction operations are not in progress.
- H. Blasting will be permitted under or adjacent to tracks only after proof that blasting is required and all methods have been approved by the MBTA's

- Chief Engineering Officer and the Railroad Company(s). All blasting operations must comply with the MBTA's "Blasting Specifications".
- I. The Owner or its Contractor shall be fully responsible for all damages arising from their failure to comply with the requirements of these specifications. Failure to comply may result in their removal from MBTA Railroad Property, at the MBTA's sole discretion.

SECTION 2. RULES, REGULATIONS, ETC.

- 2.01 Railroad traffic shall be maintained at all times with safety and continuity, and the Contractor shall conduct all operations on, over, under, within or adjacent to MBTA Railroad Property within the rules, regulations, and requirements of the Railroad Company(s) and/or MBTA. The Contractor shall be responsible for acquainting himself with such requirements as the Railroad Company(s) and/or MBTA may demand.
- 2.02 The Contractor shall obtain verification of the time and schedule of track occupancy from the Railroad Company(s) before proceeding with any construction or demolition work on, over, under, within or adjacent to MBTA Railroad Property. The work shall not proceed until the plans and method of procedure have been approved by the Chief Engineering Officer of the MBTA or his authorized representative.
- 2.03 All work to be done on, over, under, within or adjacent to MBTA Railroad Property shall be performed by the Contractor in a manner satisfactory to the MBTA and the Railroad Company(s), and shall be performed at such times and in such manner, as to not interfere with the movement of trains or operations upon the tracks of the MBTA. The Contractor shall use all necessary care and precaution in order to avoid accidents, delay or interference with the MBTA's trains or other property.
- 2.04 The Contractor shall give written notice to the Railroad Company(s) at least twenty-one (21) days prior to the commencement of any work, or any portion of the work, by the Contractor or his subcontractors on, over, under, within or adjacent to MBTA Railroad Property, in order that necessary arrangements may be made by the Railroad Company(s) to protect railroad operations.
- 2.05 If deemed necessary by the Railroad Company(s), it may assign an inspector and/or engineer who will be placed on the work site during the time the Contractor or any subcontractor is performing work on, over, under, within or adjacent to MBTA Railroad Property. The cost and expense will be paid directly by the contracting party with an advance deposit to the Railroad Company(s), unless otherwise approved.
- 2.06 Before proceeding with any construction or demolition work, on, over, under, within or adjacent to the MBTA's Railroad Property, a pre-construction meeting shall be held at which time the Contractor shall submit for approval of the MBTA and

Railroad Company(s), plans, computations, and a detailed description of the method for accomplishing the construction work, including methods of protecting railroad operations. Such approval shall not serve in any way to relieve the Contractor of complete responsibility for the adequacy and safety of the referenced methods.

- 2.07 During any demolition procedure, the Contractor must provide an approved shield to prohibit all debris from falling onto MBTA Railroad Property. A protective fence must be erected at both ends of the project to prohibit trespassers from entering MBTA Railroad Property.
- 2.08 Cranes, shovels, or any other equipment shall be considered to be fouling the track when located in such position that failure of same with or without load, brings the equipment within the fouling limit. The Contractor's employees and equipment will not be permitted to work near overhead wires or apparatus.
- 2.09 The Contractor shall conduct his work and handle his equipment and materials so that no part of any equipment should foul an operated track or wire line without the written permission of the Railroad Company(s). When it becomes necessary for the Contractor to foul any track, he must give the Railroad Company(s) written notice of his intentions twenty-one (21) days in advance, so that if approved, arrangements may be made for proper protection of the Railroad Company(s).
- 2.10 The Contractor's equipment shall not be placed or put into operation adjacent to tracks without first obtaining permission from the Railroad Company(s). Under no circumstances shall any equipment or materials be placed or stored within fifteen (15) feet from the centerline of the closest track.
- 2.11 Materials and equipment belonging to the Contractor shall not be stored on MBTA Railroad Property without first having obtained permission from the Railroad Company(s), and such permission will be on the condition that the MBTA and/or Railroad Company(s) will not be liable for damage to such materials and equipment from any cause. The Contractor shall keep the tracks adjacent to the site clear of all refuse and debris that may accumulate from construction operations, and shall leave the MBTA Railroad Property in the condition existing before construction commencement. Equipment repair, refueling or extended storage is prohibited on MBTA Railroad Property.
- 2.12 The Contractor shall consult the Railroad Company(s) in order to determine the type of protection required to insure safety and continuity of railroad operations. The railroad field engineer may assign track foremen, flagmen, signalmen or other employees deemed necessary for protective services by the Railroad Company(s), to insure the safety of trains and MBTA Railroad Property. The cost of same shall be paid directly by the contracting party with an advance deposit to the Railroad Company(s), unless otherwise approved.

- 2.13 The provision of such protective services, and other precautionary measures, shall not relieve the Contractor from liability for the cost of any and all damages caused by his operations.
- 2.14 The Railroad Company(s) will require protection during all periods when the Contractor is working on, over, under, within or adjacent to MBTA Railroad Property or as may be deemed necessary. When protection is required, the Contractor shall make the request in writing to the Railroad Company(s) at least twenty-one (21) days before such protection is required.
- 2.15 The Contractor shall not bill the Railroad Company(s) or MBTA for any work which he may perform, unless the Railroad Company(s) or MBTA authorizes the said work in writing. This work must be to the benefit of the MBTA or Railroad Company(s).
- 2. 16 The Contractor, subcontractor and respective employees who will come within the limits of the MBTA Railroad Property, must first attend the Railroad Company(s) Safety Orientation Class. They are required to comply with the Railroad Company(s) Safety Requirements throughout the entire construction period. All costs associated with compliance of the Railroad Company(s) Safety Requirements will be at the sole expense of the Contractor and subcontractors.
 - A. The Contractor for the project must appoint a qualified person who will be designated as a Safety Representative. He must be approved by the Railroad Company(s) Safety Representative. The Contractor's designee will be responsible to give Safety Orientation to the Contractor's/subcontractor's employees who will come onto the MBTA's Railroad Property for short periods of time after the initial Safety Orientation Class has been given by the Railroad Company(s). The Contractor's designee will keep the Railroad Company(s) Safety Representative informed of the temporary employees who received Safety Orientation. The Railroad Company(s) Safety Orientation Class will be repeated when employee turnover or groups of Contractor's and subcontractor's employees are such that another Railroad Company(s) Safety Orientation Class is justified.
 - B. Contractors will follow established safety procedures and remain 15 feet or more from the centerline of the closest track. When it becomes necessary for Contractors to encroach on this 15 foot limitation, the proper fouling procedures will be arranged with the Railroad Company(s).
 - C. Contractors will establish the 15 foot foul line by installing stakes and taping off the area prior to beginning work.
- 2.17 Upon completion of the work, the Contractor shall remove from the MBTA Railroad Property, all machinery, equipment, surplus materials. falsework, rubbish, temporary buildings and other property of the Contractor, or any subcontractor, and

- shall leave MBTA Railroad Property in a condition satisfactory to the MBTA and Railroad Company(s). Failure to comply will result in Railroad Company(s) forces restoring MBTA Railroad Property at the Contractor's expense.
- 2. I8 The Contractor will pay the Railroad Company(s) directly, for all protective services unless otherwise approved. The services are performed to insure safe operation of trains when construction work would, in the Railroad Company(s) opinion, be a hazard.

SECTION 3. DEFINITION OF HAZARD

- 3.01 Protection Services will be required whenever the Contractor is performing work on, over, under, within or adjacent to MBTA Railroad Property. This will include excavating, sheeting, shoring, erection, removal of forms, handling material, using equipment which by swinging or by failure could foul the track, and when any other type of work being performed, in the opinion of the Railroad Company(s), requires such service.
- 3.02 Railroad operations will be considered subject to hazard when explosives are used in the vicinity of MBTA Railroad Property during the driving or pulling of sheeting for footings adjacent to a track, when erecting structural steel across or adjacent to a track, when operations involve swinging booms or chutes that could in any way come closer than 5 feet to the center line of a track or wire line. None of these or similar operations, shall be carried on without Railroad Company(s) protective services personnel on site.
- 3.03 A signal line or communication line shall be considered fouled and subject to hazard when any object is brought closer than ten (10) feet to any wire or cable. An electrical supply line shall be considered fouled and subject to hazard when any object is brought closer than ten (10) feet to any wire of the line.
- 3.04 As excavation approaches pipes, conduits, or other underground structures on or adjacent to MBTA Railroad Property, digging by machinery shall be discontinued and the excavation shall continue by means of hand tools. All existing pipes, poles, wires, fences, property line markers, and other structures, which the MBTA and/or Railroad Company(s) decides must be preserved in place, shall be carefully protected from damage by the Contractor or its Owner. Should such items be damaged, they shall be restored by the Railroad Company(s), at the Owner's or Contractor's sole expense to the original condition prior to construction commencement. If any excavation is taken beyond the work limit indicated on the approved plans or prescribed herein, the Owner or its Contractor shall backfill and compact to the satisfaction of the Railroad Company(s) at his own expense.

SECTION 4. BACKFILL

4.01 Backfilling

- A. All backfill material adjacent to any Railroad Company(s) facility shall be approved by the Railroad Company(s). Backfill material shall be free from hard lumps and clods larger than 3 inches in diameter, and free from large rocks or stumps. Uniformly fine material shall be placed next to any pipe liable to dent or break.
- B. All backfill material shall be compacted at or near optimum moisture content, in layers not exceeding 6 inches in compacted thickness by pneumatic tampers, vibrator compactors, or other approved means to the base of the railroad subgrade. Material shall be compacted to not less than 95 percent of AASHTO T 99, Method C. The Contractor will be required to supply to the job site, ballast stone (AREA #4) to be installed by the Railroad Company(s).

4.02 Certification

The Owner or its Contractor shall provide testing, through the use of a testing lab or Professional Engineer, to insure that the inplace density of the backfill meets or exceeds the requirements of Section 4.01(B). Written certification of the tests shall be given to the Railroad Company(s) immediately upon completion of the test.

4.03 Alternate

In the case of an open cut crossing of the MBTA Railroad Property, the Owner or its Contractor may backfill with concrete having a three-day compressive strength of 1000 psi to the base of the track subgrade. This may be used in lieu of providing the certification of proper compaction when using gravel backfill. The Owner or its Contractor will be required to supply to the job site, ballast stone (AREA #4) to be installed by the Railroad Company(s).

SECTION 5. CLEARANCES

5.01 Staging falsework or forms shall at all times be maintained with a minimum vertical clearance of 226" above top of he high rail and a minimum horizontal clearance of 15' from the center line of track.

SECTION 6. PROTECTION SERVICES

- 6.01 The MBTA shall require railroad inspection and may require railroad flagging. Prior to the start of any work on MBTA Railroad Properly, the Owner or its Contractor shall submit a deposit to the amount required by the Railroad Company(s). If Railroad Company(s) expenses are greater than the amount of deposit, the Owner or its Contractor shall reimburse the Railroad Company(s) for the balance when billed, and, if the Railroad Company(s) expenses are less than the amount of deposit, the Railroad Company(s) will refund the balance to the Owner or its Contractor. The Railroad Company(s) reserves the right to request additional deposits as project work progresses.
- 6.02 If the MBTA or Railroad Company(s) determines that flagmen are necessary, the number required shall be on duty at the site during the hours of hazard described under Section 3. No work shall be performed if flagmen are required but are not on duty.
- 6.03 It shall be the responsibility of the Owner or its Contractor to keep the MBTA and Railroad Company(s) informed at all times when the Owner or its Contractor shall be working on, over, under, within or adjacent to MBTA Railroad Property and creating the hazards described under Section 3. Failure of the Owner or its Contractor to give the MBTA and Railroad Company(s) suitable advance notice of hazardous operation shall result in the shut down of the work by the Railroad Company(s), until such time as sufficient number of flagmen are on duty at the site. If this becomes a repeat occurrence, the Contractor will be removed from the project.
- 6.04 The Railroad Company(s) will make its best effort to provide protective services personnel. Should the situation arise where such personnel are not available, Contractor operations must cease. The Railroad Company(s) is not liable for any monetary claims incurred during the absence of protective services personnel.

SECTION 7. INSPECTION

7.01 If deemed necessary by the Chief Engineering Officer of the MBTA, the MBTA will furnish and assign an engineer(s) for inspection and the Railroad Company(s) will furnish an appropriate inspector for general inspection purposes or for general protection of MBTA Railroad Property and operations during construction. All protection services will be at the expense of the Owner or its Contractor.

SECTION 8. EXTRA-CONTRACT SERVICES

- 8.01 Temporary and permanent changes of tracks and all railroad utilities made necessary by the work of the Contractor, will be made by the MBTA or Railroad Company(s) at the expense of the Owner or its Contractor.
- 8.02 All other changes made or services furnished by the Railroad Company(s), at the request of the Owner or its Contractor, will be at the Owner's or its Contractor's expense.



RAILROAD OPERATIONS DIRECTORATE



INSURANCE SPECIFICATIONS

The insurance outlined in these Specifications is required of the Owner or Contractor, and shall be provided by or in behalf of all subcontractors performing any portion of the work. The Owner or Contractor shall be responsible for any modifications, deviations or omissions of the required insurance as it applies to subcontractors.

All insurance policies, unless otherwise specified under Railroad Protective Liability Insurance, are to be written either on an occurrence basis or, if a claims-made form, applicable renewals must have a date retroactive to the construction start date and shall be maintained in force for one year following the acceptance of the work by the MBTA or its duly authorized representative.

With the exception of Railroad Protective Liability Insurance, all insurance policies must name the MBTA as an additional insured as its interest appears and waive any rights of subrogation against the MBTA.

Certificates of Insurance evidencing (1) either the claims-made or occurrence form coverage, (2) work description/location, (3) Owner or Contractor's corporate name, and (4) individual, company, government agency or municipality for which the work is being performed, are to be furnished to the MBTA prior to work commencement, and within fifteen (15) days of expiration of the insurance coverage, when applicable.

<u>All</u> policies must contain a minimum thirty (30) day written notice of cancellation clause, and provide that the Insurance Company shall notify the Owner, Contractor, MBTA and Railroad Company(s), via registered mail, of any cancellation, change or expiration of the policy.

Original Insurance Certificate(s) shall be received and approved by the MBTA before the Owner or Contractor will be allowed entry upon MBTA Railroad Property. Certificates, including any required endorsements, shall be furnished to the MBTA, c/o Risk Manager, Office of the Treasurer-Controller, Ten Park Plaza, Room 8450, Boston, MA 02116, and shall provide stated coverage and a provision that Notice of Accident (occurrence) and Notice of Claim shall be given to the Insurance Company as soon as practicable after notice to the insured(s).

Original Insurance Binders reflecting Railroad Protective Insurance shall be received and approved by the MBTA and the appropriate Railroad Company(s) prior to entry upon MBTA Railroad Property. Mailing addresses for transmittal of original Insurance Binders to the named insured Railroad Company(s) are contained on Page Four of these Specifications.

The Owner or Contractor shall indemnify, defend and save harmless the MBTA and the appropriate Railroad Company(s) from and against any and all liabilities, losses (including losses of revenue), claims, costs, damages and expenses (including reasonable attorney's fees and expenses) that may be asserted against or incurred by the MBTA and the Railroad Company(s) arising from or as a result of the Owner or Contractor's work, or its use of adjacent land. Said indemnification shall include claims, whether covered by

insurance or not, including, but not limited to Workers Compensation and similar insurance.

The Owner or Contractor shall maintain, during the life of the contract, from company(s) authorized to do business in the Commonwealth of Massachusetts and satisfactory to the MBTA:

- A. <u>COMMERCIAL GENERAL LIABILITY INSURANCE</u> for personal injury, bodily injury and property damage in an amount not less than \$1,000,000 per occurrence and \$3,000,000 in the aggregate covering all work performed on over or adjacent to MBTA Railroad Property (the "work"), including:
 - 1. All operations;
 - 2. Contractual liability;
 - 3. Coverage for the so-called "X, C, U" hazards, i.e., collapse of building, blasting, and damage to underground property;
 - 4. Asbestos abatement, when applicable.
- **B.** <u>AUTOMOBILE LIABILITY INSURANCE</u> including the use of all vehicles owned, non-owned, leased and hired, in an amount not less than \$2,000,000 combined single limit covering all the work.
- C. <u>WORKER'S COMPENSATION INSURANCE</u> including <u>Employees, Liability</u> <u>Insurance</u>, as provided by Massachusetts General Laws, Chapter 152, as amended, covering all the work.
- **D.** <u>UMBRELLA LIABILITY COVERAGE</u> in an amount not less than \$5,000,000 per occurrence covering all the work.
- **E. HAZARDOUS MATERIALS INSURANCE** if the work involves hazardous materials, the following coverage is required:
 - 1. **Pollution Liability insurance** for sudden and gradual occurrences in an amount not less than \$1,000,000 per occurrence and \$5,000,000 in the aggregate arising out of the work, including but not limited to all hazardous materials identified in the contract.

- 2. When applicable, the Owner or Contractor shall designate the disposal site and furnish a Certificate of Insurance from the Disposal Facility for Environmental Impairment Liability Insurance for (a) sudden and accidental occurrences in an amount not less than \$3,000,000 per occurrence and \$6,000,000 in the aggregate and (b) non-sudden occurrences in an amount not less than \$5,000,000 per occurrence and \$10,000,000 in the aggregate.
- 3. Certificates of insurance shall clearly state the hazardous materials exposure work being performed.
- F. RAILROAD PROTECTIVE LIABILITY INSURANCE is specifically designed for insuring Railroads, and is purchased by the Owner or Contractor in the name of the MBTA and the Railroad Company(s). The Railroad Company(s) is the named insured on the policy. Railroad Protective Liability Insurance is required for any work performed within fifty (50) feet from center line of the nearest railroad track; it is not a substitute for any types of insurance outlined in these Specifications. Required limits are:

<u>Bodily injury</u>: not less than \$2,000,000 for all damages arising out of bodily injuries to or death of one person, and subject to that limit for each person, a total limit of \$6.000,000 for all damages arising nut of bodily injury to or death of two or more persons in any one accident;

<u>Property Damage</u>: not less than \$2,000,000 or all damages arising out of injury to or destruction of MBTA property in any one accident, and subject to that limit per accident, a total of \$6,000,000 in the aggregate for all damages arising out of injury to or destruction of MBTA property.

Questions regarding insurance should be directed to MBTA's Risk Manager at (617) 222-4447.

Questions regarding train counts and train speeds should be directed to the appropriate Railroad Company(s) listed on Page Four.

PROOF OF INSURANCE MAILING ADDRESSES:

Co.

MBTA Risk Manager

c/o Treasurer-Controller

10 Park Plaza Boston, MA 02116

cc: MBTA Real Estate Management

National Railroad
Passenger Corporation
(Amtrak)
Boston Division Office
c/o Division Engineer
32 Cobble Hill Road

Somerville, MA 02143

<u>Consolidated Rail</u> Chief Engineer

<u>Corporation</u> Design and Construction

2201 Market Street - 11C

P. O. Box 41411

Philadelphia, PA 19101

(215) 209-3874/Denise Boyle

<u>Bay Colony Railroad</u>
<u>Corporation</u>
General Manager
4 Freight House Road

East Wareham, MA 02571

<u>Boston and Maine Corporation</u> Chief Engineer and Springfield Terminal Railway 402 Amherst Street

Suite 300

Nashua, NH 03063-1287

Providence and Worcester P. O. Box 1188

Railroad Company Worcester, MA O1601



RAILROAD OPERATIONS DIRECTORATE

IV

PIPELINE OCCUPANCY SPECIFICATIONS

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SECTION I. GENERAL REQUIREMENTS

1.01 DESCRIPTION OF WORK AND LOCATION

These specifications apply to the design and construction of pipelines carrying flammable and non-flammable substances and to casings over 4-inches in diameter containing wires and cables, under, across or along MBTA Railroad Property, facilities and tracks.

1.02 LICENSE TO ENTER RAILROAD PROPERTY

- A. Entry upon MBTA Railroad Property for the purpose of conducting surveys, field inspections, obtaining soil information, or any other purpose associated with the design and engineering of the proposed occupancy, will be authorized by an MBTA License for Entry (See "Guidelines and Procedures for Construction on MBTA Railroad Property").
- B. Issuance of the License does not constitute authority to proceed with the actual construction.

1.03 WORK ON RAILROAD PROPERTY

- A. The safety and continuity of train operations shall be the first priority. The Applicant shall arrange the work so that the trains will be protected and safeguarded at all times. Whenever the work may affect the safety and movement of trains, the method, sequence and time schedule of performing such work shall be submitted to the MBTA's Chief Engineering Officer or his authorized representative for approval.
- B. The Applicant waives all claims against the Railroad Company(s) and/or the MBTA for delays or any interference occasioned by railroad traffic or railroad maintenance.
- C. All Applicant-designed temporary construction on MBTA Railroad Property, shall be designed in accordance with the appropriate railroad criteria and all construction performed on, over, under, within or adjacent to MBTA Railroad Property will he subject to the inspection and approval of the Railroad Company(s) and/or MBTA.
- D. A minimum of fourteen (14) days advance written notice shall be given to the Railroad Company(s) prior to construction related activities.
- E. The Railroad Company(s) will furnish such qualified flagmen, signalmen or protection men as may be required to insure complete protection of train operations and railroad facilities. The need for this type of service will be determined by the Railroad Company(s) on the basis of railroad regulations

- and the Applicant's approved construction schedule. No work shall proceed without proper protection on the site.
- F. All expenses incurred in connection with protection of railroad facilities by Railroad Company(s) employees will be borne by the Applicant. Billings for such service or expense, including labor, materials and equipment will be made directly to the Applicant for payment.
- G. During construction, railroad traffic shall be maintained at all times without interruption, except when approved in advance, in writing, by the Chief Engineering Officer or his authorized representative.
- H. All construction operations shall be conducted so as not to interfere with, interrupt, or endanger the operation of trains, nor damage, destroy, or endanger the integrity of railroad facilities. All work on or near MBTA Railroad Property shall be conducted in accordance with the Railroad safety rules and regulations. The Applicant shall secure and comply with the Railroad safety rules and shall give written acknowledgment to the Railroad Company(s) that they have been received, read, and understood by the Applicant and his employees. Construction operations will be subject to Railroad Company(s) inspection at any and all times.
- I. All cranes, lifts, or other equipment that will be operated in the vicinity of the MBTA's electrification and power transmission facilities shall be electrically grounded as directed by the Railroad Company(s).
- J. At all times when the work is progressing, a field supervisor for the work with no less than twelve (12) months experience in the operation of the equipment being used shall be present. Certification of the above must be submitted to the Railroad Company(s).

- K. Whenever equipment or personnel are working closer than fifteen (15) feet to the centerline of an adjacent track, that track shall be considered as being obstructed. Insofar as possible, all construction operations shall be conducted no less than this distance. Construction operations closer than fifteen (15) feet to the centerline of a track shall be conducted only with the permission of, and as directed by, a qualified Railroad Company(s) employee present at the work site.
- L. Crossing of tracks at grade by equipment and personnel is prohibited except by prior arrangement with, and as directed by, the Chief Engineering Officer or his authorized representative.
- M. All tunneling, jacking and boring operations within railroad influence lines will be done on a 24 hour per day basis to minimize Railroad exposure to construction hazards.

1.04 COORDINATION

The Applicant shall coordinate his work with his contractors, subcontractors, utility companies, governmental units, and any affected Railroad Company(s) with regard to site access, establishment and use of temporary facilities, work schedules, and other elements of the specified work which require interfacing with others.

1.05 LAYOUT OF WORK

The Applicant shall lay out his work true to lines and grades indicated on the drawings and shall be responsible for all measurements in connection therewith. The Applicant will be held responsible for the execution of the work to such lines and grades indicated on the approved construction drawings or such other lines and grades as may be directed or established by the Chief Engineering Officer or his authorized representative.

1.06 INDEMNIFICATION AND INSURANCE

See requirements in "Guidelines and Procedures for Construction on MBTA Railroad Property" and "Insurance Specifications."

1.07 SCIENTIFIC OR HISTORIC ARTIFACTS

The Applicant shall immediately notify the Chief Engineering Officer of the discovery of scientific or historical artifacts and shall protect same until identified and removed by the appropriate Authorities exercising jurisdiction.

1.08 RECORD DOCUMENTS

- A. The Applicant shall furnish the Railroad Company(s) and the MBTA with one reproducible "As Built" copy of each approved Construction Drawing, marked to indicate all changes and deviations from same.
- B. All project record documents shall be received and accepted by the MBTA and the Railroad Company(s) prior to final inspection.

SECTION 2. SUBMITTALS

2.01 APPLICATION FOR OCCUPANCY

The Applicant must agree, upon approval of the construction details by the Chief Engineering Officer, to execute the MBTA Pipeline Occupancy Agreement and pay any required fees and/or rentals outlined therein. Refer to "Guidelines and Procedures for Construction on MBTA Railroad Property" for application policy.

2.02 SUBMISSION OF CONSTRUCTION PLANS AND SPECIFICATIONS

- A. Six (6) sets of plans and specifications for proposed pipeline occupations shall be submitted to the Director of Real Estate and meet the approval of the Railroad Company(s) and the MBTA prior to the start of construction. These plans are to be prepared in sizes as small as possible arid are to be folded to an 8-1/2 inch by 11-inch size (folded dimensions) with a 1-1/2 inch margin on the left side and a 1-inch margin on the top.
 - 1. After folding, the title block and other identification of the plans shall be visible at the lower right corner, without the necessity of unfolding. Each plan shall bear an individually identifying number and an original date, together with subsequent revision dates, clearly identified on the plan.
 - 2. All plans are to be individually folded or rolled and where more than one plan is involved, they shall be assembled into complete sets before submission to the MBTA.
- B. Draw plans to scale and show the following (see attached Plates).
 - 1. Plan view of proposed pipeline in relation to all railroad facilities.
 - 2. Location of pipe (in feet) from nearest railroad milepost, centerline of a railroad bridge (giving bridge number), or centerline of an existing or former passenger station, or other fixed point. In all cases, the name of the City or Town and County in which the proposed facilities

are located must be shown.

- 3. Profile of ground on centerline of pipe from field survey showing relationship of pipe and casing to ground level, tracks and other facilities. For longitudinal occupations, the profile of adjacent track(s) must be shown.
- 4. All MBTA property lines. If pipeline is in a public highway, the limits of the right-of-way for the highway shall be clearly indicated with dimensions from centerline.
- 5. The angle of crossings in relation to centerline of tracks.
- 6. Location of valves or control stations of the pipeline.
- 7. "Pipe Crossing Data Sheet" completed and out on Plan.
- C. The plan must be specific (both on MBTA Railroad Property and under tracks that are not on MBTA Railroad Properly) as to:
 - Method of installations.
 - 2. Size and material of casing pipe.
 - 3. Size and material of carrier pipe.

These items shall not have an alternative.

- D. Once an application is approved by the Chief Engineering Officer or his authorized representative, proposed variances from the approved plans, specifications, method of construction, etc., will be resubmitted for approval.
- E. Location and dimensions of jacking, boring, or tunneling pits shall be shown with details of their sheeting and shoring. If the bottom of the pit excavation nearest the adjacent track intersects a line from a point 5.5 feet horizontally from center line of adjacent track at the plane of the base of fall drawn on a slope of 2 horizontal to 1 vertical, submit design and details of the pit construction to the MBTA for approval complete with computations prepared by a Registered Professional Engineer. In any event, the face of the pit shall be no less than 25 feet from adjacent track, unless otherwise approved by the Chief Engineering Officer or his authorized representative. Pits shall be fenced, lighted, and otherwise protected as directed by the Railroad Company(s).
- F. All plans and computations, including those submitted by contractors, must bear the seal of a Registered Professional Engineer.
- G. Computations for all structures involving the support or protection of railroad

track, embankment and facilities must be prepared by and bear the seal of a Registered Professional Engineer and shall be submitted within the construction plans.

- H. When computer calculations are included with design calculations, the following documentation shall be furnished:
 - A synopsis of the computer program(s) stating briefly required input, method of solution, approximations used, second order analysis incorporated, specifications or codes used, cases considered, output generated, extent of previous usage of certification of program(s) and program(s) author.
 - 2. Identification by number, indexing and cross-referencing of all calculation sheets, including supplemental "long-hand" calculation sheets.
 - 3. Fully identified, dimensioned, and annotated diagram of each member or structure being considered.
 - 4. Clear identification and printing of all input and output values, including intermediate values if such values are necessary for orderly review.
 - 5. Identification of the processing unit, input/output devices, storage requirements, etc., if such supplemental information is significant and necessary for evaluation of the submittal.
- I. Specifications shall conform to Construction Specifications Institute (CIS) 16 Division, 3-part Section Format.
- J. If other than American Railway Engineering Association (AREA), American Society for Testing and Materials (ASTM), or American National Standards Institute (ANSI) specifications are referred to for design, materials or workmanship on the construction plans and specifications for the work, then copies of the applicable sections of such other specifications referred to shall accompany the construction plans and specifications for the work.

SECTION 3. TEMPORARY FACILITIES AND CONTROLS

3.01 REQUIREMENTS OF REGULATORY AGENCIES

Applicant shall:

- A. Obtain and pay all costs for required permits for installation and maintenance of temporary facilities and controls.
- B. Comply with all applicable Federal, State and local codes, regulations and ordinances.
- C. Comply with regulations and requirements of all utility or service companies from which temporary utilities or services are obtained, and pay all costs incurred therewith.

3.02 INSTALLATION AND COORDINATION - GENERAL

Applicant shall:

- A. Install all temporary facilities and controls in a neat and orderly manner.
- B. Make all temporary facilities structurally and functionally sound throughout.
- C. Construct temporary facilities and controls to give continuous service and to provide safe working conditions.
 - 1. Enforce conformance with applicable standards
 - 2. Enforce safe practices.
- D. Modify, extend or relocate temporary facilities and controls as work progress requires.
- E. Locate temporary facilities and controls to avoid interference with, or hazards to:
 - 1. Work or movement of railroad personnel or traffic.
 - 2. Vehicular traffic.
 - General Public.
 - 4. Work of other contracts.
 - Railroad Passengers.
- F. Obtain easements as may be required across non-MBTA Railroad Property.
- G. Provide materials for temporary facilities and controls for the purpose intended and shall not violate requirements of applicable codes and shall not

create unsafe conditions.

3.03 SANITARY FACILITIES

Prior to the start of work, the Applicant shall furnish necessary toilet conveniences, secluded from public observation. They shall be kept in a clean and sanitary condition and comply with the requirements and regulations of the area in which the work is performed.

3.04 LIGHT AND POWER

Applicant shall make his own arrangements for obtaining temporary light and power as required for the work, and shall maintain such temporary facilities in a proper and safe condition, including compliance with applicable codes.

3.05 TEMPORARY WATER

Applicant shall make his own arrangements for obtaining all temporary water service as required for the work.

3.06 TEMPORARY TRAFFIC CONTROLS

Applicant shall cooperate with the directives of the MBTA and/or Railroad Company(s) regarding vehicular traffic control and provide any temporary controls or devices required to eliminate or minimize congestion or obstruction of vehicular traffic caused by the work, including use of designated routes of ingress and egress from the work area.

3.07 TEMPORARY WORK AND STORAGE AREAS

- A. The areas designated by the MBTA as the temporary parking, work and storage area(s) will be provided to the Applicant in accordance with the terms of the MBTA License Agreement.
- B. All designated temporary parking, work and storage areas used by the Applicant shall be restored to their original condition prior to completion of the work, subject to inspection and approval of the MBTA and the Railroad Company(s).

3.08 POLLUTION ABATEMENT CONTROLS

Applicant shall:

- A. Conduct operations in a manner to minimize pollution of the environment surrounding the area of work by every means possible. Specific controls shall be provided as follows:
 - 1. <u>Vehicles</u>: All vehicles and material transport trucks leaving the site and entering paved public streets shall be cleaned of mud and dirt clinging to the body and wheels of the vehicle. Trucks arriving at or leaving the site with materials shall be loaded in a manner which will prevent dropping of materials or debris on the streets. Spills of materials in public areas shall be removed immediately at no cost to the MBTA or Railroad Company(s).
 - Waste Materials: No waste or erosion materials shall be allowed to enter natural or man-made water or sewage removal systems. Erosion materials from excavations, borrow areas or stockpiled fill shall be contained within the work area. The Applicant shall develop methods for control of waste and erosion which shall include such means as filtration, settlement and manual removal to satisfy the above requirements. Do not dispose of machinery lubricants, fuels, coolants and solvents on the site. If hazardous waste is encountered, the Applicant shall dispose of it in accordance with all federal, state and local codes. Verification of proper disposal must be provided, in writing, to the MBTA and the Railroad Company(s).
 - 3. <u>Burning</u>: No burning of waste shall be allowed without prior written permission. In cases where permission is granted, burning shall be conducted in accordance with the regulations of :the appropriate jurisdictional agency.
 - 4. <u>Dust Control</u>: The Applicant shall at all times control the generation of dust by his operations. Control of dust is mandatory and shall be accomplished by water sprinkling or by other methods approved by the MBTA or Railroad Company(s).
 - 5. <u>Noise Control</u>: The Applicant shall take every action possible to minimize the noise caused by his operation. When required by agencies having jurisdiction, noise producing work shall be performed during less sensitive hours of the day or week as directed by the MBTA or Railroad Company(s) or as required by local ordinance.

- 6. <u>Environmental</u>: All local and state environmental laws will be strictly adhered to. All applications, permits. licenses, approvals, etc., will be the sole responsibility of the Applicant.
- B. Submit a program for pollution control with applicable licenses and permits for all piping carrying non-potable liquids, gases or other pollutants.

3.09 PROTECTION OF PERSONS AND PROPERTY

A. Safety Requirements

- 1. The Applicant must adhere to the most stringent provisions of the applicable statutes and regulations of the political subdivision in which the work is being performed. The Applicant must also observe the Department of Labor-Occupational Safety, Health Administration provision, pertaining to the safe performance of the work, and further, the methods of performing the work must not involve undue danger to the personnel employed thereon, Railroad Company(s) employees, the public, or to public and private property. Should charges of violation of any of the above be issued to the Applicant in the course of the work, a copy of each charge shall immediately be forwarded to the Railroad Company(s). The Applicant shall pay all fines and penalties levied against him.
- 2. The Applicant shall erect and maintain, as required by existing conditions and progress of the work, all reasonable safeguards for safety and protection. This includes posting danger signs and other warnings against hazards, promulgating safety regulations and notifying owners and users of adjacent utilities.
- B. <u>Safety of Persons and Property</u> The Applicant shall take all reasonable precautions for the safety of, and shall provide all reasonable protection to prevent damage, injury or loss to:
 - 1. All employees on the work site and all other persons who may be affected.
 - 2. All materials and equipment, whether in storage on or off the site, under the care, custody or control of the Contractor or any of his subcontractors.
 - ---3. Other property at the site or adjacent thereto, including walks, pavements, roadways, structures, and utilities not designated for removal, relocation or replacement in the course of construction. Any damage to such items shall be restored to original condition by the Applicant at no cost to the MBTA or Railroad Company(s).

C. First Aid

The Applicant shall maintain adequate first aid supplies at the site as prescribed by Federal, State or Local codes and regulations.

D. Use of Explosives

Non blasting methods are preferred. See "Blasting Specifications."

E. Site Security

The Applicant shall:

- Maintain a secure work site protecting the MBTA and the Railroad Company(s) interests and property from claims arising from trespass, theft and vandalism.
- 2, Permit access to the work site only to employees, contractors and those persons having business related to the work.
- 3. Provide security measures as required to protect his or his subcontractor's tools, equipment and property from damage, theft or vandalism.
- 4. Assume all costs for any MBTA and/or local police details required by the work.

3.10 VERMIN CONTROL

- A. Do not permit food scraps, lunch bags, food wrappers or other items which would attract rats or other vermin to be left lying around the site. Deposit such items in closed, rat-proof metal containers for disposal on a regular basis.
- B. The Applicant must provide vermin control as required by the MBTA or Railroad Company(s).

3.11 RUBBISH AND DEBRIS REMOVAL

- A. Rubbish and debris resulting from the work must be neatly piled in a single location and legally disposed of at least once a week. If rubbish or debris interferes with railroad activities, or creates a fire or safety hazard, it must be removed on a more frequent basis.
- B. Volatile waste such as mineral spirits, oil, or paint thinner shall not be

disposed of in storm or sanitary drains, streams or waterways or any location upon the site.

SECTION 4. PIPELINE OCCUPANCY GENERAL CRITERIA

GENERAL:

4.01 METHOD OF INSTALLATION:

A In a public way:

- 1. No work shall be done without a Railroad Company(s) Inspector present.
- 2. Open cuts will not be allowed in or immediately adjacent to an at grade crossing. Sleeves will be installed by the jerking method, unless otherwise approved by the Chief Engineering Officer.
- 3. Jerking is the preferred method of installation in or immediately adjacent to an at grade crossing. The sleeve may be installed by the open cut method with the Applicant paying for the complete rebuilding of the crossing, pending approval of MBTA's Chief Engineering Officer. Approval will be given only under very unusual circumstances.
- 4. Jacking is the preferred method of installation in or immediately adjacent to an at grade crossing scheduled for rebuilding. The sleeve may be installed by the open cut method within seven (7) calendar days of the scheduled date of the crossing reconstruction. In the case of any open cut, strict adherence shall be made to the backfill specifications which provide the MBTA with written certification from a testing lab or Professional Engineer, that the backfill density requirements of the MBTA specifications have been met or exceeded.

B. Not within a Public Way:

The preferred method of crossing the railroad is by jacking of a pipe sleeve under the railroad. Only upon written request, will an alternate of open cut be given consideration. The engineering decision shall he based upon, but not limited to, the following: (1) track usage, (2) depth of cut, (3) soil conditions, (4) physical restraints. In the event an open cut is allowed, the following items shall be adhered to, and (5) any other circumstances which may necessitate an open cut.

1. The installation is to be a continuous operation and performed according to an MBTA approved schedule.

- 2. No work shall be done without a Railroad Company(s) Inspector present.
- 3. MBTA backfill specifications by the Owner or its Contractor.
- 4. The Owner or its Contractor may be required to provide a nonrefundable lump sum payment for "after the fact maintenance." The
 determination of this amount is based on the individual situation. No
 work will be allowed until this payment is received. This payment is
 not to be confused with payments for plans and specification review,
 flagging, inspection, etc. (also required from the Owner or its
 Contractor before he enters upon MBTA property.)

4.02 GENERAL REQUIREMENTS

- A. Pipelines under or across MBTA tracks on rights-of-way shall be encased in a larger pipe or conduit called the casing pipe as indicated in Plate II.
- B. Casing pipe will be required for all pipelines carrying oil, gas, petroleum products, or other flammable, highly volatile substances which, from their nature or pressure, might cause damage if escaping on or near MBTA Railroad Property.
- C. For non-pressure sewer or drainage crossings where the installation can be made without interference to railroad operations, the casing pipe may be omitted when the pipe strength is capable of withstanding railroad loading. This type of installation must be approved by the MBTA's Chief Engineering Officer.
- D. The casing pipe shall be laid across the entire width of the right-of-way. Casing pipe shall extend beyond the right-of-way when the right-of-way line on either side of the tracks is less than the minimum length of casing specified in Section 6, Para. 6.01(E).
- E. Pipelines laid longitudinally on railroad right-of-way shall be located in accordance with Plate III. If located within 25 feet of the centerline of any track or closer than 45 feet to nearest point of any bridge, building or other structure, the carrier pipe shall be encased.
- F. Where practicable, pipelines shall be located to cross the tracks at approximate right angles, but preferably at not less than 45 degrees.
- G. Pipelines shall not be placed within a culvert, under railroad bridges, or closer than 45 feet to any portion of a railroad bridge, building, or other structure, except in special cases, and then by special design, as approved by the Chief Engineering officer.

- H. Pipelines carrying liquified petroleum gas shall, where practicable, cross the railroad where tracks are carried on embankment.
- I. Any replacement or modification of an existing carrier pipe and/or casing shall be considered a new installation, subject to the requirements of these Specifications.
- J. Where laws or orders of public authority prescribe a higher degree of protection than specified herein, the higher degree so prescribed shall be deemed a part of these Specifications.
- K. Pipelines and casings shall be suitably insulated from underground conduits carrying electric wires on MBTA Railroad Property.

4.03 INSPECTION AND TESTING

For pipelines carrying flammable or hazardous materials, ANSI Codes B 31.8 and B 31.4, current at time of constructing the pipeline, shall govern the inspection and testing of the facility on MBTA Railroad Property, except that proof-testing of strength of carrier pipe shall be in accordance with the requirements of ANSI Code B 31.4, as applicable, for all pipelines carrying all liquified petroleum gas, natural or manufactured gas, and other flammable substances.

4.04 CATHODIC PROTECTION

- A. Cathodic protection shall be applied to all pipelines and casings carrying flammable substances.
- B. Where casing and/or carrier pipe is cathodically protected by other than anodes, the Chief Engineering Officer shall be notified and suitable testing shall be made. This testing shall be witnessed by the Railroad Company(s) to insure that other railroad structures and facilities are adequately protected from the cathodic current in accordance with the recommendations of Reports of Correlating Committee on Cathodic Protection, current issue by the National Association of Corrosion Engineers.

4.05 SOIL INVESTIGATIONS

- A. Soil borings (or other soil investigations approved by the Railroad Company(s) will be performed to determine the nature of the underlying material for all pipe crossings under tracks. See Test Boring Specifications".
- B. Borings shall be made on each side of the tracks, on the centerline of the pipe crossing, and as close to the tracks as practicable.
- C. Soil borings shall be in accordance with the current issue of the American Railway Engineering Association Specifications, Chapter 1, Part 1, "Specifications for Test Borings". Soils shall be investigated by the spoon and/or thin-walled tube method and rock shall be investigated by the Boring method specified therein.
- D. Soil boring logs shall clearly indicate <u>all</u> of the following:
 - 1. Boring number as shown on boring location plan.
 - 2. Elevation of ground at boring, using same datum as the pipeline construction plans.
 - 3. Description or soil classification of soils and rock encountered.
 - 4. Elevations or depth from surface for each change in strata.
 - 5. Identification of where samples were taken and percentage of recovery.
 - 6. Location of ground water at time of sampling and, if available, subsequent readings.
 - 7. Natural dry density in lbs./sq. ft. for all strata.
 - 8. Unconfined compressive strength in tons/sq. ft, for all strata.
 - 9. Water content (percent). Liquid limit (percent) and plastic limit (percent).
 - 10. Standard penetration in blows/ft.
- E. The location of the carrier pipe and casing shall be superimposed on the boring logs before submission to the Chief Engineering Officer.
- F. Soil investigation by auger, wash, or rotary drilling methods are not acceptable.
- G. Soil boring logs shall be accompanied by a plan drawn to scale showing location of borings in relation to the tracks and the proposed pipe location, the elevation of around surface at each boring, and the elevation of the base of rail of the tracks.

4.06 GROUND STABILIZATION

Soil stabilization shall take place prior to the start of jacking. Stabilization shall be achieved by dewatering, grouting or a combination of both to maintain the stability of the face of the heading.

- A. The Owner or its Contractor shall lower and maintain the ground water level a minimum of two (2) feet below the invert at all times during construction by well points, vacuum well points, or deep wells to prevent inflow of water and/or soil into the heading. Ground water observation wells shall be installed in the area to be dewatered to demonstrate that the dewatering requirements are being complied with.
- B. The grouting contractor shall be a specialist in the field with a minimum of five (5) continuous years of successfully grouting soils. All granular soils (silty sands, sand or sand and gravel) shall be stabilized by injection of a cement or chemical grout from the ground surface or from the pipe heading. The stabilization shall extend as far as necessary outside the periphery of the casing pipe in order to maintain a stable face at the heading.
- C. Railroad Company(s) forces will survey the crossing prior to, during and after construction. If it is necessary to align or surface the tracks as a result of construction, the Railroad Company(s) will perform the work at the expense of the Owner or the Owner's Contractor.

4.07 SUPPORT OF TRACKS

- A. When jacking, boring, or tunneling, temporary track support structures will be installed. The track support structures will he provided by the Applicant and installed by the Railroad Company(s) at the Applicant's expense. The type of temporary track support structures shall be approved by the Railroad Company(s)'
- B. All work involving rail, signals, ties and other track material will be performed by the Railroad Company(s) at the Applicant's expense.
- C. The Applicant shall deliver the track support structures to a site approved by the Railroad Company(s). Provisions for unloading will be provided by the Applicant at no expense to the Railroad Company(s) and the Applicant will provide the necessary labor to handle the material for pre-installation inventory.

4.08 GEOTECH MONITORING

THE FOLLOWING SPECIFICATIONS ARE REQUIRED FOR ALL PIPE JACKING OPERATIONS.

- A. Jacking will be on a continuous basis, 24 hours per day, 7 days per week.
- B. The monitoring points will be set up one week before the jacking operation begins. The MBTA and Railroad Company(s) shall be notified. Elevation readings shall begin two days prior to the start of jacking and continue for a minimum of two weeks after the completion of the jacking operation. Initial readings immediately after any surfacing operations shall serve as new baseline figures. All future elevation readings shall be compared to the adjusted baseline. If the track deviates to a condition not acceptable to the MBTA or Railroad Company(s), corrections will be made at the proponent's expense.
- C. Elevation readings will be taken from the top fall of each track.
- D. Elevation readings will be taken every four hours or two times per shift, i.e., six times per day. The readings will be faxed to the MBTA and Railroad Company(s) on a daily basis and all information is to be presented in legible print. Additional readings may be required by the MBTA or Railroad Company(s).
- E. Stations will be spaced at 15-1/2 foot intervals. The number of stations required will be determined by the depth of the pipe. There will be a minimum of two stations on either side of the centerline jacking. Additional stations may be required by the MBTA or Railroad Company(s),
- F. Elevation readings must show the date, time, weather conditions and temperature. Each reading must also provide the following information: track number, compass direction, station number, base elevation (with date), static elevation, change in elevation (recorded in hundredths and in inches), dynamic reading and total deflection in inches. See sample sheet attached.
- G. Station "0" will be located at the centerline of the pipe jacking with Stations 1 and being to the right and Stations -1 and -2 being to the left when standing in the gauge of the near track and looking at the receiving pit. In multiple track areas the stations as determined herein are to be carried across each track perpendicular to the near track.
- H. Elevation readings taken from the top of the rail for static measurement and the dynamic readings shall be combined and the sum compared to the adjusted baseline. This reading will demonstrate the difference in elevation

caused by the jacking operation.

I. The MBTA requires that the truck be maintained at all times within established criteria for the specific track classification. At the completion of the project the requirement for tamping and realigning the tracks, caused by the settlement from the construction activity, remains with the proponent for the duration as specified by the MBTA in their initial review of the work plans. This tamping and track realignment will be performed by the MBTA or Railroad Company(s) at the sole expense of the proponent.

4.09 PIPELINES ON BRIDGES

- A. Pipelines carrying flammable or non-flammable substances which by their nature might cause damage if escaping on or near railroad facilities or personnel, shall not be installed on bridges over railroad tracks or bridges carting railroad tracks.
- B. The Chief Engineering Officer may approve such an installation when it is demonstrated that no practicable alternative is available.
- C. When allowed by the Chief Engineering Officer, pipelines on bridges shall be located as to minimize the possibility of damage from vehicles, railroad equipment, vandalism and other external causes. Pipelines on bridges may be installed in a utility bay that is constructed between the girders of the bridge. The utility bay will be protected from the environment by a removable shield bolted to the girders. This will allow utility companies to comply with the Code of Federal Regulations for Periodic Inspection.
- D. In the event of pipe relocation due to the reconstruction of a bridge, the installation of the new pipe must comply with the requirements in these Specifications.

4.10 BONDING AND GROUNDING OF PIPELINES IN ELECTRIFIED TERRITORY

- A. Carrier pipe shall be enclosed in a metal casing that is isolated from carrier pipe by approved insulators having a dielectric value of not less than 25 k.v. that provide an air gap between carrier pipe and casing of not less than 2 inches.
- B. Carrier pipe supporting hangers, mountings or cradles shall provide an insulation value of not less than 25 k.v. and an air gap of not less than 2 inches between casing and any portion of mounting assembly.
- C. Any grounding or isolation methods used must have a minimum dielectric of 25,000 volts.

4.11 ABANDONED PIPELINES OR FACILITIES

- A. For all pipeline occupations on the railroad right-of-way, the owner of the pipeline shall notify the MBTA, in writing, of the intention to abandon the pipeline. Upon abandonment the carrier pipe shall be removed and the casing shall be filled with cement grout, compacted sand or other material approved by the Chief Engineering Officer. If it is impractical to remove the carrier pipe, then the carrier must be filled along with the annular space between the casing and carrier.
- B. Facilities other than pipelines will be removed or altered at abandonment to the satisfaction of the Chief Engineering Officer.

4.12 DRAINAGE

- A. Occupancies shall be designed, and constructed, so that adequate and uninterrupted drainage of railroad right-of-way is maintained. If it becomes necessary to block a ditch, pipe or other drainage facility, the applicant shall install temporary pipes, ditches or other drainage facilities as required to maintain adequate drainage, as approved by the MBTA or Railroad Company(s). Upon completion of the work, the temporary drainage facilities shall be removed and the permanent facilities restored.
- B. Water may not be pumped or disposed of onto railroad rights-of-way unless discharged into an existing drainage facility, providing discharge does not cause erosion or leave sediment.
- C. When water runoff is disposed of onto MBTA Railroad Property, it must be demonstrated to the Railroad Company(s) that the existing drainage facility can accommodate the increased runoff. Drainage calculations stamped by a Registered Professional Engineer must accompany all requests to use railroad culverts or drainage ditches.
- D. If in the estimation of the Chief Engineering Officer or his authorized representative, the railroad culvert or drainage ditch has to be cleaned in order to allow the increased flow to safely pass through the culvert, it must be cleaned at the expense of the applicant.

SECTION 5. CARRIER PIPE

GENERAL:

5.01 DESIGN CRITERIA

A. If the maximum allowable stress in the carrier pipe on either side of the occupancy of MBTA Railroad Property is less than specified herein, the

- carrier pipe on MBTA Railroad Property shall be designed at the same stress as the adjacent carrier pipe.
- B. Requirements for carrier pipe under railroad tracks shall apply for a minimum distance equal to that of the casing pipe.
- C. Carrier pipes within a casing shall be designed for railroad live loads as if they were not encased.
- D. All pipes, ditches and other structures carrying surface drainage on MBTA Railroad Property and/or crossing under railroad tracks shall be designed to carry the run-off from a one hundred (100) year storm. Computations indicating this design and suitable topographic plans, prepared by a Registered Professional Engineer, shall be submitted to the Chief Engineering Officer, or his authorized representative, for approval. If the drainage is to discharge into an existing drainage channel on railroad right-of-way and/or under railroad tracks, the computations should include the hydraulic analysis of any existing structures. Submitted with the computations should be formal approval of the proposed design by the appropriate governmental agency.

PRODUCTS:

5.02 GENERAL

- A. All pipes shall be designed for the external and internal loads to which they will be subjected. The dead load of earth shall be considered 120 pounds per cubic foot. Railroad live loading shall be Cooper's E-8O with 50% added for impact. On railroad right-of-way or where railroad loading will be experienced, the following shall be the minimum requirements for carrier pipes:
 - 1. Reinforced concrete pipe ASTM Spec. C-76, Class V, Wall C.
 - 2. Ductile Iron Pipe For Culverts and Gravity Sewers ASTM Spec, A-142 Extra Heavy.

5.03 OIL AND GAS PIPES

A. Pipelines carrying oil, liquified petroleum gas, natural or manufactured gas and other flammable products shall conform to the requirements of the current ANSI B 31.4, with Addenda, "Liquified Petroleum Transportation Piping Systems," ANSI B 31.8, "Gas Transmission and Distribution Piping Systems," and other applicable ANSI codes, except that the minimum allowable stresses for the design of steel pipe shall not exceed the following percentages of the specified minimum yield strength (multiplied by the

longitudinal joint factor) of the pipe as defined in the ANSI Codes:

- 1. Steel pipe within a casing under, across and longitudinally on MBTA Railroad Property. (The following percentages apply to hoop stress):
 - a. Seventy-two percent for installation on oil pipelines.
 - b. Fifty percent for pipelines carrying liquified petroleum gas and other flammable liquids with low flash point.
 - c. Sixty percent for installations on gas pipelines.
- 2. Steel pipe without a casing laid longitudinally on MBTA Railroad Property. (The following percentages apply to hoop stress):
 - a. Sixty percent for installations on oil pipelines.
 - b. Forty percent for pipelines carrying liquified petroleum gas and other flammable liquids with low flash point.
 - c. Forty percent for installations on gas pipelines.
- B. Design computations showing compliance with the requirements of Paragraph 5.03(A) above, and prepared by a Registered Professional Engineer, shall accompany the application for occupancy.
- 5.04 CAST IRON PIPE: For water and other materials under pressure shall conform to the current ANSI specifications A-21 Series 21/45 Iron strength with plain end, compression type or mechanical joints. The strength to sustain external railroad and other loadings shall be computed in accordance with the current ANSI A-21.1 "Thickness Design of Cast Iron Pipe."
- 5.05 VITRIFIED CLAY PIPE: ASTM Spec C-700, Extra Strength.
- 5.06 CORRUGATED METAL PIPE: AREA Spec Chapter I, Part 4
- 5.07 ASBESTOS CEMENT PIPE (Non-pressure): ASTM Spec. C-428, C1. 5000 Min. Pressure: AWWA Spec. C400, C1. 150 Min.
- 5.08 OTHER: Other miscellaneous piping not specified above shall be submitted to approval by the Chief Engineering Officer.
- 5.09 SHUT-OFF VALVE
 - A. Provide accessible emergency shut-off valves at each side of the railroad within distances and at locations as directed by the Chief Engineering Officer.
 - B. Where pipelines are provided with automatic control stations and within distances approved by the Chief Engineering Officer, no additional valves will be required.

5.10 SIGNS

- A. Prominently identify all pipelines at rights-of-way by durable, weatherproof signs located over the centerline of the pipe. Mark pipelines at under crossings on both sides of track. Signs shall display the following:
 - 1. Name and address of pipeline Owner.
 - 2. Contents of Pipe.
 - 3. Pressure in Pipe.
 - 4. Depth below grade at point of sign.
 - 5. Emergency telephone in event of pipe rupture.
 - Railroad File Number.
- B. For pipelines running longitudinally on MBTA Railroad Property, place signs over the pipe (or offset and appropriately mark) at all changes in direction the pipeline. Locate signs so that when standing at one sign, the next adjacent marker in either direction is visible. In no event shall pipeline identification signs be placed more than 500 feet apart, unless otherwise directed by the Chief Engineering Officer.
- C. Submit details of signs (materials, size, methods of support, etc.) to the Chief Engineering Officer for approval.

EXECUTION:

5.11 INSTALLATION:

- A. Install carrier pipes in accordance with approved Construction Drawings, requirements of this specification, and all applicable codes and ordinances.
- B. Install carrier pipes with sufficient slack so they are not in tension.

SECTION 6. CASING PIPE

GENERAL:

6.01 DESIGN CRITERIA

- A. Casing pipe and joints shall be of metal and of leakproof construction.
- B. Casing pipe shall be designed for the earth and/or other pressures present, and for railroad live load. The dead load of earth shall be considered 120 pounds per cubic foot. Railroad Live load shall be Cooper E-80 with 50g added for impact.

- C. The inside diameter of the casing pipe shall be such as to allow the carrier pipe to be removed subsequently without disturbing the casing or the roadbed. For carrier pipe less than six (6) inches in diameter, the inside diameter of the casing pipe shall be at least two (2) inches greater than the largest outside diameter of the carrier pipe joints or couplings. For carrier pipe six (6) inches and over in diameter, the inside diameter of the carrier pipe shall be at least four (4) inches greater than the largest outside diameter of the carrier pipe joints or couplings.
- D. For flexible casing pipe, a minimum vertical deflection of 3 percent of its diameter, plus 1/2 inch, shall be provided so that no loads from the roadbed, track, traffic or casing pipe itself are transmitted to the carrier pipe. When insulators are used on the carrier pipe, the inside diameter of the flexible casing pipe shall be at least two (2) inches greater than the outside diameter of the carrier pipe for pipe less than eight (8) inches in diameter; at least 3-1/4 inches greater for pipe 8 to 16 inches in diameter, and at least 4-1/2 inches greater for pipe 18 inches and over in diameter. In no event shall the casing pipe diameter be greater than is necessary to permit the insertion of the carrier pipe.
- E. Casing pipe under railroad tracks and across MBTA Railroad Property shall extend the <u>Greater</u> of the following distances, measured at right angles to centerline of track:
 - 1. Across the entire width of MBTA Railroad Property.
 - 2. Two (2) feet beyond ditch line.
 - 3. Three (3) feet beyond toe of slope.
 - 4. A minimum distance of 25 feet each side from centerline of outside track when casing is sealed al both ends.
 - 5. A minimum distance of 45 feet from centerline of outside track when casing is open at both ends.
- F. If additional tracks are constructed in the future, the casing shall be extended at the expense of the Applicant.
- G. Table of Live Loads

LIVE LOADS, INCLUDING IMPACT, FOR VARIOUS HEIGHTS OF COVER FOR COOPER E- 80

COVER(FT) LOAD(PSF) COVER(FT) LOAD(PSF) COVER(FT) LOAD(PSF)

2 3800 10 1100 20 300 5 2400 12 800 30 100

8 1600 15 600

6.02 PROTECTION AT ENDS OF CASING

- A. Casings for carriers of flammable substances shall be sealed to the outside of the carrier pipe. Details of seals shall be shown on the plans.
- B. Casings for carriers of non-flammable substances shall have both ends of the casing blocked in such a way as to prevent the entrance of foreign material, but allowing leakage to pass in the event of a carrier break.
- C. Where ends of casing are at or above ground surface and above high water level, they may be left open, provided drainage is afforded in such a manner that leakage will be conducted away from railroad tracks and structures.

6.03 VENTS

- A. Sealed casings for flammable substances shall be properly vented. Vent pipes shall be of sufficient diameter, but in no case less than two (2) inches in diameter, and shall be attached near each end of the casing and project through the ground surface at right-of-way lines or not less than 45 feet (measured at right angles from centerline of nearest track).
- B. Vent pipes shall extend at least four (4) feet above the ground surface. Top of vent pipe shall have a down-turned elbow, properly screened, or a relief valve. Vents in locations subject to high water shall be extended above the maximum elevation of high water and shall be supported and protected in a manner approved by the Chief Engineering Officer.
- C. Vent pipes shall be at least four (4) feet from the closest aerial electric wires.
- D. When the pipeline is in a public highway, street-type vents shall be installed.

PRODUCTS:

6.04 STEEL PIPE

The minimum yield strength for steel pipe will be 35,000psi. Smooth wall pipes with a nominal diameter greater than 70 inches require special approval by the Chief Engineering Officer. See Plate V, "Table of Minimal Wall Thickness for Steel Casing Pipe."

6.05 CAST IRON PIPE

May be used for a casing, provided the method of installation is by open trench. Cast iron pipe shall conform to ASTM Specification A-142, Extra Heavy. The pipe shall be of the mechanical joint type or plain end type with compression type couplings.

6.06 CORRUGATED METAL PIPE AND CORRUGATED STRUCTURAL PLATE PIPE

May be used for casing only when emplaced by the open-cut method. Jacking or boring through railroad embankment is not permitted. Pipe shall be bituminous coated and shall conform to AREA Specifications Chapter 1, Part 4.

6.07 REINFORCED CONCRETE PIPE

Shall conform to ASTM Specification C 76, Class V, Wall C. It shall be used only in the open cut and jacking methods of installation. If concrete pipe is to be jacked into place, grout holes tapped for at least 1-1/2 inch pipe spaced at approximately 8 feet around the circumference and approximately 4 feet longitudinally shall be cast into the pipe at manufacture. Immediately upon completion of jacking operations, the installation shall be pressure grouted.

6.08 TUNNEL LINER PLATES

Shall be four flange and otherwise conform to American Railway Engineering Association Specifications Chapter 1, Part 4. In no event shall the liner plate thickness be less than 0.1046 inches. Tunnel liner plates are to be used only to maintain a tunneled opening until the carrier pipe is installed. After installation the annular space between the carrier and liner must be filled with 1:6 cement grout or lined with 6 inches of concrete, reinforced with 6x6-6/6 wire mesh for tunnels up to 108 inches in diameter. Required thickness of lining for larger tunnels will be determined by span and structural analysis. Manufacturer's Shop Detail plans and manufactures computations showing the ability of the tunnel liner plates to resist the jacking stresses shall be submitted to the Chief Engineering Officer for approval.

EXECUTION:

6.09 DEPTH OF INSTALLATION:

- A. Casing pipe under railroad tracks and across MBTA Railroad Property shall be at least 6-1/2 feet from top of rail to top of casing at its closest point. Under secondary or industrial tracks this distance will be at least 5-1/2 feet. On other portions of MBTA Railroad Property where casing is not directly beneath any track, the depth from ground surface or from bottom of ditches to top of casing shall be at least four (4) feet, unless otherwise specified herein.
- B. Pipelines laid longitudinally on MBTA Railroad Property 50 feet or less from

centerline of track, shall be buried not less than five (5) feet from ground surface to top of pipe. This applies to all pipelines carrying oil, gas, petroleum products, or other flammable or highly volatile substances under pressure, and all non-flammable substances which by their nature or presence in the judgment of the Chief Engineering Officer may be hazardous to life or property. For pipelines carrying water, sewage and non-flammable substances, the distance from surface of ground to top of pipe shall not be less than four (4) feet.

- C. Pipelines located within the line of track live load influence (as shown on Plates II and III) are subject to railroad loading and require a casing or are to be of special design approved by the Chief Engineering Officer. All longitudinal occupation locations must be approved by the Chief Engineering Officer.
- D. The minimum cover shall be at least three (3) feet when pipeline is laid more than 50 feet from center line of track.
- E. Pipelines installed under or adjacent to any overhead structure must be a minimum of 29 feet from the bottom of the structure to the top of the casing. Such installations must comply with the above requirements.

6.10 METHOD OF INSTALLATION

- A. The Owner or its Contractor shall submit to the Chief Engineering Officer, data and information demonstrating that he or his subcontractor has had successful previous experience in jacking, or using the proposed method of installation, in similar situations.
- B. Before any work is begun within the limits of jacking, the Owner or its Contractor shall have assembled all tools, materials, and equipment which will be required. When the Owner or its Contractor has started the jacking operation, he will proceed in a continuous operation without stopping. This will minimize the tendency of the material to freeze around the pipe.
- C. A jacking shield shall be used and jacked ahead of the casing pipe. The excavation within the jacking pipe should not advance beyond the head of the pipe shield. If the stability at the face needs to be maintained from raveling or running soil, suitable temporary bulkheads, struts, and bracing shall be required. After completion of the sleeve installation the annular space around it shall he completely grouted with cement grout under pressure.
- D. Casing pipe ends shall he beveled with a single V-groove toe field welding. Pipe joints shall be butt welded and shall be a full penetration on the outside circumference of the pipe. The single V-groove butt weld shall conform to the latest A.W.S. Welding Code. All joints of the easing pipe shall be butt

welded, by a certified welder, prior to being subject to the jacking operation.

Alternate method: The casing pipe may be jacked without being butt welded through the use of a continuous 1/2"x12" interior collar plate. The collar plate shall be welded completely upon completion of the jacking operation. All welding shall conform to the latest A.W.S. Welding Code, and shall be performed by a certified welder.

6.11 CONSTRUCTION:

- A. The casing pipe shall be constructed so as to prevent leakage of any substance from the casing throughout its length, except where the ends are left open, or through vent pipes when the ends are sealed. The casing shall be installed so as to prevent the formation of a waterway under the railroad, shall have an even bearing throughout its length, and shall slope to one end (except for longitudinal occupancy).
- B. Casing pipes shall be installed by the following methods:

1. Jacking

- a. This method shall be in accordance with the most current edition of the American Railway Engineering Association Specifications, "jacking Culvert Pipe Through Fills." This operation shall be conducted without handmining ahead of the pipe and without the use of any type of boring, auguring, or drilling equipment.
- b. Bracing and backstops shall be designed and jacks of sufficient rating used so that the jacking will be continuous.

2. Drilling

This method employs the use of an oil field type rock roller bit or a plate bit made up of individual roger cutter units which is welded to the pipe casing being installed and which is turned as it is advanced. The pipe is turned for its entire length from the drilling machine to the ground being drilled. A high density slurry is injected through a small supply line to the head which acts as a cutter lubricant. This slurry is injected at the rear of the cutter units to prevent any jetting action ahead of the pipe. The drilling machine runs on a set of steel rails and is advanced (thus advancing the pipe) by a set of hydraulic jacks. The method is the same whether earth or rock is being drilled. Any other drilling methods shall be submitted to the Chief Engineering Officer for approval.

3. Tunneling

Tunneling operations shall be conducted as approved by the Railroad Company(s). Care shall be exercised in trimming the surface of the excavated section in order that the steel liner plates fit snugly against the undisturbed material. Excavation shall not be advanced ahead of the previously installed liner plates any more than is necessary for the installation of the succeeding liner plate. The vertical face of the excavation shall be supported as necessary to prevent sloughing. At any interruption of the tunneling operation, the heading shall be completely bulkheaded. Tunneling shall be conducted continuously, on a 24 hour basis until the tunnel liners extend at least one foot beyond the railroad line of influence.

- b. When tunneling, tight breasting must be maintained around the entire face. On any shutdowns (under or beyond railroad influence line, see Plate II), the entire face will be fully breasted and packed with hay.
- c. The tail void shall be filled with pea stone (or other approved material) simultaneously with each advancement of the shield.
- d. An ample supply of hay and/or sandbags must be kept at the site to fill any voids caused by the removal of large stones or other obstructions extending outside the shield.
- e. A uniform mixture of 1:6 cement grout shall be placed under pressure behind the liner plates, in addition to the previously placed pea stone. Grout holes, tapped for at least 1-1/2 inch pipe and spaced 3 feet around the tunnel liner, shall be placed in every other ring. Grouting shall start at the lowest dole and proceed upwards. A threaded plug shall be installed in each grout hole as the grunting is completed at that hole.
- f. Grouting shall be kept as close to the heading as possible, using grout stops behind the liner plates. if necessary, grouting shall proceed as directed by the Railroad Company(s), but in no event shall more than six lineal feet of tunnel be progressed beyond the grouting.

4. Tunneling Shields

a. All pipes 70 inches and larger in diameter shall be emplaced with the use of a tunneling shield, unless otherwise approved by the Chief Engineering Officer. Pipes of smaller diameter may also require a shield when, at the sole discretion of the

Chief Engineering Officer, soil, or other conditions indicate its need.

- b. The shield shall be of steel construction, designed to support railroad track loading as specified in Paragraph 6.01 B herein, in addition to other loadings it must sustain. The advancing face shall be provided with a hood, extending no less than 20 inches beyond the face and extending around no less than the upper 240 degrees of the total circumference. Installations made with linear plates shall be provided with a full 360 degree shield. It shall be of sufficient length to permit the installation of at least one complete ring of liner plates within the shield before it is advanced for the installation of the next ring of liner plates, It shall conform to and not exceed the outside dimensions of the pipe being emplaced by more than one inch at any point in the periphery.
- c. The shield must be adequately braced and provided with necessary appurtenances for completely bulkheading the face with horizontal breastboards, and arrange so that the excavation can be benched as may be necessary. Excavation shall not be advanced beyond the edge of the hood, unless otherwise approved by the Railroad Company(s).
- d. Manufacturer's Shop Detail plans and computations showing the ability of the tunnel liner plates to resist the jacking stresses shall be submitted to the Chief Engineering Officer for approval.
- e. For jacking reinforced concrete pipe, the shield shall be fabricated as a special section of reinforced concrete pipe with the steel cutting edge, hood, breasting attachments, etc., cast into the pipe. The wall thickness and reinforcing shall be designed for the jacking stresses.
- f. Grout holes tapped for no less than 1-1/2 inch pipe, spaced at approximately 3 foot centers around the circumference of the shield (or the aforementioned special reinforced concrete section) and no more than 4 foot centers longitudinally shall be provided.
- g. Detail plans sufficient to determine the adequacy of the shield, accompanied with design calculations prepared by a Registered Professional Engineer, shall be submitted to the Chief Engineering Officer for approval and no work shall proceed until such approval is obtained.

5. Boring

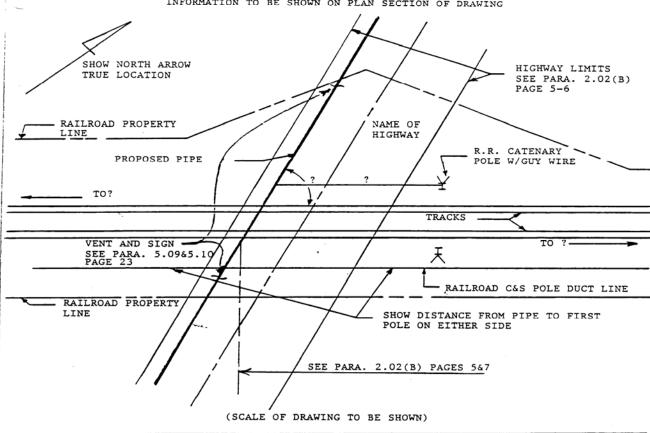
- a. This method consists of pushing the pipe into the fill with a boring auger rotating within the pipe to remove the spoil. When augers, or similar devices, are used for pipe emplacement, the <u>front of the pipe</u> shall be provided with mechanical arrangements or devices that will positively prevent the auger and cutting head from leading the pipe so that there will be no unsupported excavation ahead of the pipe. The auger and cutting head arrangement shall be removable from within the pipe in the event an obstruction is encountered. The over-cut by the cutting head shall not exceed the outside diameter of the pipe by more than one-half inch. The face of the cutting head shall be arranged to provide reasonable obstruction to the free flow of soft or poor material.
- b. Plans and descriptions of the auger stop arrangement to be used shall be submitted to the Chief Engineering Officer for approval, and no work shall proceed until such approval is obtained and the arrangement is inspected in the field by the Railroad Company(s).
- c. The use of water or other liquids to facilitate casing emplacement and/or spoil removal is prohibited.
- d. Any method which employs simultaneous boring and jacking or drilling and jacking for pipes over 8 inches in diameter which does not have the above approved arrangement <u>WILL NOT BE PERMITTED</u>. For pipes 8 inches and less in diameter, auguring or boring without this arrangement may be considered for use only as approved by the Chief Engineering Officer.
- C. If an obstruction is encountered during the installation which stops the forward action of the pipe, and it becomes evident that it is impossible to advance the pipe, operations will cease and the pipe shall be abandoned in place and filled completely with grout, in accordance with Section 4, Paragraph 4.10.
- D. Bored or jacked installations shall have a bored hole essentially the same as the outside diameter of the pipe plus the thickness of the protective coating. If voids should develop or if the bored hole diameter is greater than the outside diameter of the pipe (plus coating) by more than 1 inch, grouting or other methods approved by the Railroad Company(s) shall be employed to fill such voids.

- E. Pressure grouting or freezing of the soils before or during jacking, boring, or tunneling may be required at the direction of the Railroad Company(s) to stabilize the soils, control water, prevent loss of material and prevent settlement or displacement of the embankment and/or tracks. Grout shall be cement, chemical or other special injection material selected to accomplish the necessary stabilization.
- F. The materials to be used and the method of injection shall be prepared by a Registered Professional Engineer (Geotechnical), or by an experienced and qualified company specializing in this work and submitted for approval to the Railroad Company(s) before the start of work. Proof of experience and competency shall accompany the submission.
- G. When water is expected to be encountered, pumps of sufficient capacity shall be provided and maintained at the site, and continually attended on a 24-hour basis, until in the sole judgment of the Railroad Company(s), their operation can be safely halted. When dewatering, close observation shall be maintained to detect any settlement or displacement of railroad embankment, tracks, and facilities.
- H. Proposed methods of dewatering must be submitted to the Railroad Company(s) for approval prior to implementation. The discharge from the dewatering operations in the vicinity of the railroad shall be carefully monitored. If in the opinion of the Railroad Company(s), there is an excessive loss of fine soil particles at any time during the dewatering process, the dewatering will be halted immediately. The dewatering operation cannot resume until the unsatisfactory condition is remedied to the satisfaction of the Railroad Company(s).



PIPE CROSSING

INFORMATION TO BE SHOWN ON PLAN SECTION OF DRAWING



NOTE:

IF MANHOLES ARE PLACED ON MBTA RAILROAD PROPERTY, DETAILS OF SAME, WITH CLEARANCES TO THE CENTERLINE OF THE NEAREST TRACK ARE TO BE SHOWN ON THE DRAWINGS.

IF THE PROPOSED PIPE IS TO SERVE A NEW DEVELOPMENT, A MAP SHOWING THE AREA IN RELATION TO STABLISHED AREAS AND ROADS IS TO BE SENT WITH THE REQUEST.

THE PROPOSED PIPE IS NOT WHOLLY WITHIN HIGHWAY LIMITS, THE SAME INFORMATION IS REQUIRED AS SHOWN ON THIS PLATE.

PLATE II

PIPE CROSSING

INFORMATION TO BE SHOWN ON PROFILE SECTION OF DRAWING

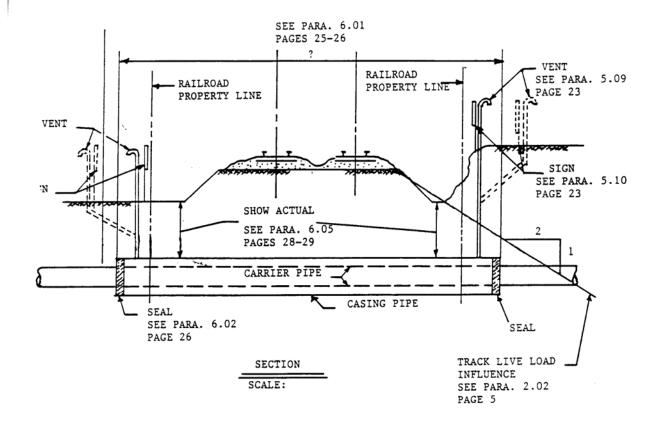


PLATE III LONGITUDINAL OCCUPANCY RAILROAD PROPERTY LINE SEE PARA. 4.02(E) PAGE 15 RAILROAD PROPERTY LINE ELEVATION LONGITUDINAL PIPELINE SEE PARA. 6.09 PAGES 28-29 R.R. DUCT LINE 2 1 TRACK LIVE LOAD INFLUENCE SEE PARA. 2.02(E) PAGE 5 ELEV 140 PROFILE OF GROUND ALONG CENTERLINE OF PIPE 130 PROFILE OF TOP OF RAIL OF ADJACENT TRACK 120 - PROFILE OF PIPE 110 100 3+00 2+50 2+00 1+50 3+50 4+00 STATIONING PROFILE - SEE PARA. 2.02 PAGES 5-7 SCALE - HOR:

VER:

PLATE IV

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PIPE CROSSING DATA SHEET

In addition to plan and profile of crossing, drawings submitted for the Railroad Company(s) approval shall contain the following information:

		Pipe Date
	Carrier Pipe	Casing Pipe
Contents To Be Handled		
Normal Operating Pressure		
Normal Size of Pipe		
O.S. Diameter		
I.S. Diameter		
Wall Thickness		
Weight Per Foot		
Material		
Process of Manufacture		·
Specification :		
Grade or Class		
Test Pressure		
Type of Joint		
Type of Coating		
Details of Cathodic Protection		
Details of Seal or Protection at Ends of Casing		
Method of Installation		
Character of Subsurface Material At the Crossing Location		
Approximate Ground Water Level		
Source of Information on Sub- surface conditions (Test Pits, Borings or Other)		

NOTE: Any soil investigation made on MBTA Railroad Property or adjacent to tracks shall be carried on under the supervision of the Railroad Company(s).

TABLE OF MINIMUM WALL THICKNESS FOR STEEL CASING PIPE (FOR INFORMATION ONLY)

PROTECTED WALL THICKNESS

PIPE SIZE	WALL THICKNESS
(INCHES)	(PROTECTED)
10	0.375
12	0.375
14	0.375
16	0.375
18	0.375
20	0.375
22	0.375
24	0.375
26	0.375
28	0.406
30	0.469
32 •	0.501
34	0.532
36	0.532
38	0.569
40	0.569
42	0.569
~~. 44	0.594
46	0.688
48	0.688
50	0.688
52	0.813
54	0.813
56	0.876
58	0.876
60	0.876
62	0.876
64	0.876
66	0.876
68	0.876
70	0.906

NOTE: FOR UNPROTECTED PIPE 26" AND UNDER ADD 0.032" TO PROTECTED WALL THICKNESS. FOR UNPROTECTED PIPE 28" AND OVER ADD 0.063" TO PROTECTED WALL THICKNESS.



V

SPECIFICATIONS FOR WIRE CONDUIT AND CABLE OCCUPATIONS

SECTION 1. SCOPE

1.01 These specifications apply to the design of electric transmission wires and cables (power and communication) which are to be located over, under. across or upon property, facilities, and tracks owned by the MBTA.

SECTION 2. LICENSE TO ENTER MBTA RAILROAD PROPERTY

- 2.01 Individuals, corporations. or municipalities desiring wire or cable occupations must agree, upon approval of the construction details by the Chief Engineering Officer, to execute an appropriate occupational agreement and pay any required fees and/or rentals outlined therein.
- 2.02 Application for an occupancy shall be submitted in writing to:

Director of Real Estate MBTA, 10 Park Plaza Boston, Massachusetts 02116

See "Guidelines and Procedures for Construction on MBTA Railroad Property."

2.03 All applications shall be accompanied with six (6) copies of all construction plans, specifications and computations concerning the proposed occupancy.

SECTION 3. APPROVAL OF PLANS

- 3.01 Entry upon MBTA Railroad Property for the purpose of conducting surveys, field inspections, obtaining soil information, or any other purpose associated with the design and engineering of the proposed occupancy, will be permitted only with a proper entry permit prepared by the MBTA Real Estate Department. The issuance of such a permit does not constitute authority to proceed with the actual construction. Construction cannot begin until the proper insurance certificate is received and a formal agreement is executed by the MBTA and permission is received by the Railroad Company(s).
- 302 Plans shall be drawn to scale and show the following: (See attached plates I VI)
 - A. Plan view of crossing or occupation in relation to all Railroad Company(s) facilities. (See Plate 1)
 - B. Location of wire or cane (in feet) from nearest railroad mile post, center line of a railroad bridge (giving bridge number), or center line of a passenger station. In all cases, the name of the County and City or Town in which the proposed facilities are located must be shown.
 - C. Profile of ground on center line of pole or tower line, showing

clearances between top of rail and bottom of sag, as well as clearances from bottom wire or cable to top wire or cable of the MBTA's transmission, signal and communication lines and catenary. If none of these facilities are in existence at the point of crossing, the plan should so indicate. Actual under-clearances are to be shown. (See Plate V for the required clearances).

- D. Show all known property lines. If wires, cables or conduits are within public highway limits, such limits should be clearly indicated with dimensions from center line.
- E. The plan must be specific as to:
 - Base diameter, height, class and bury of poles. Poles shall be set no closer than 13'6" from face of pole to center line of nearest track. When necessary, however, each location will be analyzed to consider speed, traffic, access, etc.
 - 2. Number, size and material of power wires, as well as number of pairs in communication cables.
 - 3. Nominal voltage of line, type of current and frequency.
 - 4. Number, location, size and material of anchors and all guying for poles and arms.

NOTE: Double cross-arms are required on poles adjacent to track. Any tower designs must be accompanied by engineering computations and data.

SECTION 4. CONSTRUCTION REQUIREMENTS

- 4.01 Power and communication lines shall be constructed in accordance with "Safety Rules for the Installation and Maintenance of Electric Supply and Communication Lines, National Electrical Safety Code Handbook, Part 2" (current issue), with the following exceptions:
 - A. Item 3 (c), page 2.
 - B. Casing pipes to contain power or communication wires or cables having an outside diameter of over four (4) inches shall be constructed in accordance with the current issue of MBTA Railroad Operations "Pipeline Occupancy Specifications".

SECTION 5. LONGITUDINAL OCCUPATIONS

- 5.01 Wires and cables running longitudinally along railroad right-of-way shall be constructed as close to MBTA property lines as possible in accordance with Plate III. For electrical power lines and cables with voltages of 34,500 or over and communication canes containing over 180 pairs, the following information must be submitted in addition to the detail of the pole top configuration as called for on Plate IV of these specifications:
 - A. Voltage of circuit(s) or number of pairs.
 - B. Phase of electrical circuit(s).
 - C. Number of electrical circuits.
 - D. Size (AWG or CM) and material of wires and cables.
- 5.02 Any facilities overhanging MBTA Railroad Property must have approval of the MBTA and appropriate rental charges will be applied.

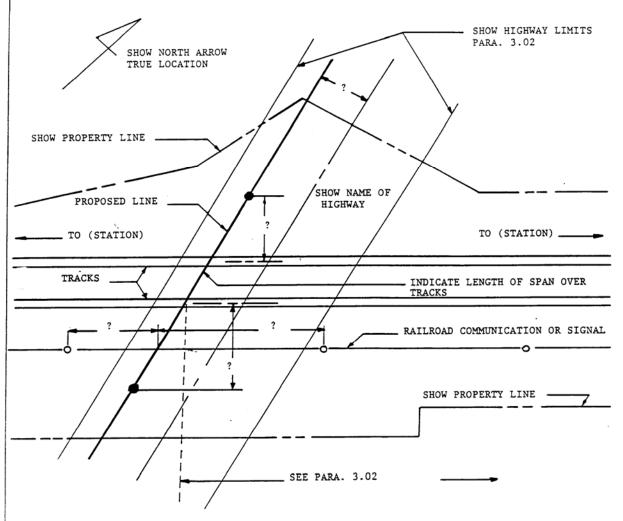
SECTION 6. INDUCTIVE INTERFERENCE

6.01 On agreements covering longitudinal occupations, provisions will be included that the applicant will provide appropriate remedies, at his own expense, to correct any inductive interference with MBTA facilities.

PLATE I

PLAN VIEW

INFORMATION TO BE SHOWN ON PLAN SECTION OF DRAWINGS WHEN FACILITY IS A CROSSING



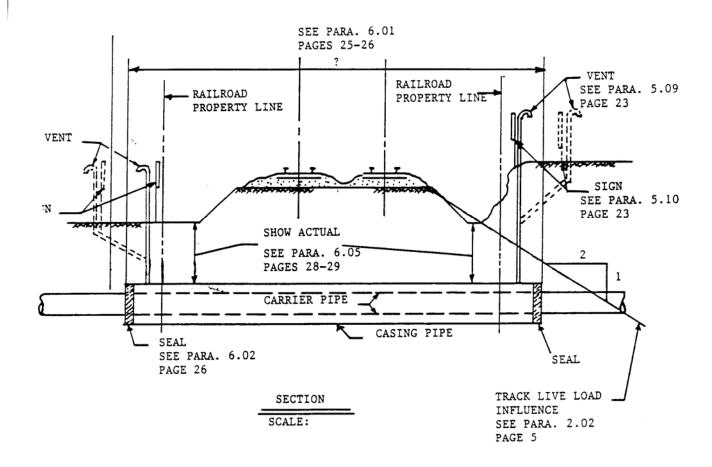
SCALE OF DRAWING TO BE SHOWN

NOTE:

- IF THE PROPOSED LINE IS TO SERVE A NEW DEVELOPMENT, A MAP SHOWING THE AREA IN RELATION TO ESTABLISHED AREAS AND ROADS IS TO BE SENT WITH THE REQUEST.
- IF THE PROPOSED LINE IS NOT WHOLLY (OR PARTIALLY) WITHIN HIGHWAY LIMITS, THE SAME INFORMATION IS REQUIRED AS SHOWN ON THIS PLATE.

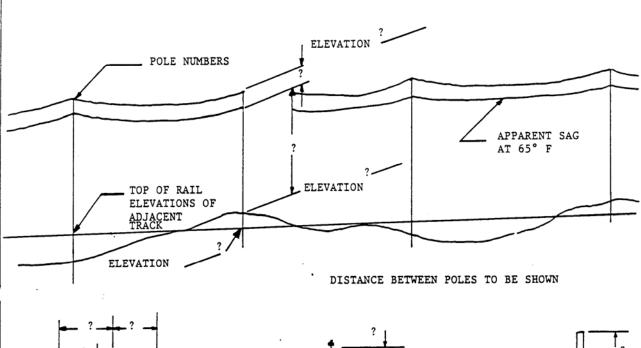
PIPE CROSSING

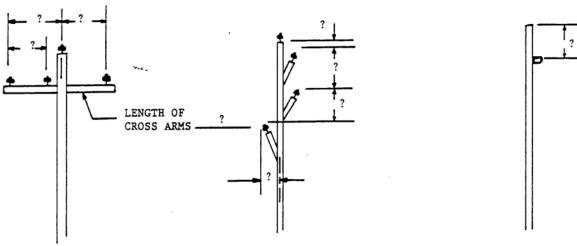
INFORMATION TO BE SHOWN ON PROFILE SECTION OF DRAWING



PROFILE VIEW

INFORMATION TO BE SHOWN ON PROFILE SECTION OF DRAWINGS IN CASES OF LONGITUDINAL OCCUPATIONS





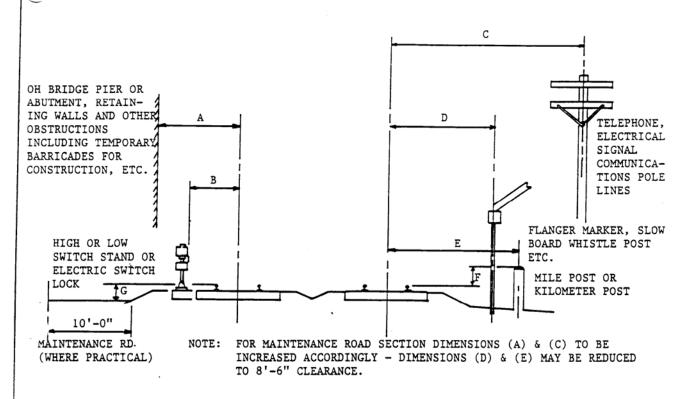
POLE TOP CONFIGURATION TO BE SHOWN SIMILAR TO SAMPLES ABOVE

 ${{{\rm NOTE}}}\colon$ IF POWER LINE CROSSES ANY TRACK, THEN INFORMATION SHOWN ON PLATE II IS ALSO REQUIRED.

PLATE IV

STANDARD SIDE CLEARANCES - TANGENT TRACK

(FOR OBSTRUCTIONS OTHER THAN PASSENGER STATIONS)



DIMENSION	w	DESCRIPTION

A	GENERAL MINIMUM SIDE CLEARANCE OVERHEAD BRIDGE PIERS & ABUTMENT, RETAINING WALLS & OTHER EXISTING STRUCTURES	8'-6" 8'-6"
В	LOW SWITCH STANDS (3'-0" MAX HEIGHT) HIGH SWITCH STANDS (OVER 3'-0" HEIGHT) ELECTRIC SWITCH LOCKS	6'-6" 9'-0" 6'-6"
С	POLE LINES - TELEPHONE, ELECTRIC, SIGNAL COMMUNICATIONS (MIN)	13'-6"
D	AUTOMATIC UT CONT. III CON	12'-0" 8'-6" 15'-0"
E	MILE POSTS - HORIZONTAL	13'-6"
F	MILE POSTS - VERTICAL	7'-0"
G	DEPRESSION OF MAINTENANCE ROAD	

PLATE V

OVERHEAD CLEARANCE

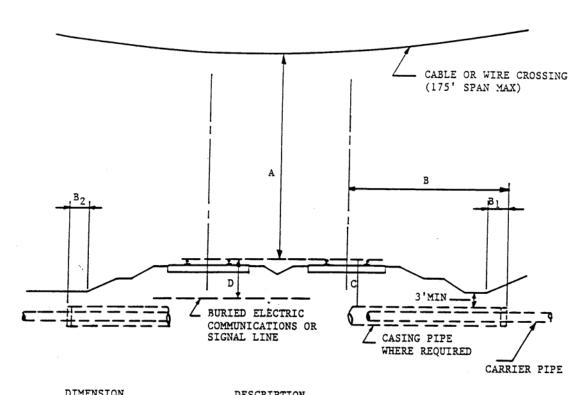
(Top of Rail to Bottom of Sag)

VOLTAGE	Bottom of Sag)	
0 - 750 750 - 15,000 15,000 - 50,000 69,000 115,000 138,000 345,000 500,000 745,000 Other than power lines	27'0" 28'0" 30'0" 30'8" 32'2" 33'0" 39'10" 45'0" 53'2" 53'10" 27'0"	

(Calculation is 30'0" + 0.4" per 1,000 volts over 50,000 volts)

PLATE VI

CLEARANCES FOR OVERHEAD AND BURIED UTILITY CROSSINGS



DIMENSION	DESCRIPTION		
A	POWER LINES 0 TO 750V POWER LINES 750V to 15,000V POWER LINES 15 to 50KV OTHER THAN POWER LINES	27'-0" 28'-0" 30'-0" 27'-0"	At 120°F Ambient Temperature
В	SEALED ENDED CASINGS OPEN ENDED CASINGS	25'-0" 45'-0"	
B ₁	END CASING DEYOND DITCH	2'-0"	
B ₂	END CASING BEYOND SLOPE	3'-0"	
С	CASING PIPE CARRIER PIPE WITHOUT CASING	4'-6" 6'-6"	
D	BURIED ELECTRIC LINES RAILROAD SIGNAL LINES (220V) COMMUNICATIONS LINES	6'-6" 2'-6" 3'-6"	



VI

BRIDGE ERECTION, DEMOLITION AND HOISTING OPERATIONS

Submittals for bridge erection, demolition, or other hoisting operations shall be prepared and stamped by a Registered Professional Engineer and must include the following:

- 1. Plan view showing locations of crane or cranes, operating radii, with delivery or disposal locations shown.
- 2. Crane rating sheets showing cranes to be adequate for 150% of the lift. Crane and boom nomenclature is to be indicated.
- 3. Plans and computations showing weight of picks.
- 4. Location plan showing obstructions, indicating that the proposed swing is possible.
- 5. Data sheet listing type and size of slings or other connecting equipment. Include copies of catalog cuts or information sheets of specialized equipment. The method of attachment must be detailed on the erection plan. All lifting components must be adequate for 150% of the lift.
- 6. A complete procedure indicating the order of lifts and any repositioning or rehitching of the crane or cranes.
- 7. Plans detailing temporary support of any components or intermediate stages.
- 8. A time schedule (by hour and day) of the various stages, as well as a schedule for the entire lifting procedure.



VII

TEMPORARY SHEETING AND SHORING

The following items are to be included in the design and construction procedures for all permanent and temporary facilities on, over, under, within or adjacent to MBTA Railroad Property:

- 1. Footings for all piers, columns, walls or other facilities shall be located and designed so that any temporary sheeting and shoring for support of adjacent track or tracks during construction will not be closer than toe of ballast slope. (See dimensions in the MBTA's Book of Standard Plans, #1000 and #1002 for tangent and curved track). Sheeting will be required when excavation is inside of a line which extends horizontally from 5.5 feet off center line of adjacent track, then on a 2 (horizontal) to 1 (vertical) slope. This is known as the zone of influence.
- 2. Where physical condition of design impose insurmountable restrictions requiring the placing of sheeting closer than specified above, the matter must be submitted to the Chief Engineering Officer for approval of any modifications.
- 3. When support of track or tracks is necessary during construction of above mentioned facilities, interlocking steel sheeting adequately braced and designed to carry E-80 live load plus 50% impact is required. Soldier piles and lagging will be permitted for supporting adjacent track or tracks only when required penetration of steel sheet piling cannot be obtained or when in the opinion of the Chief Engineering Officer, or his authorized representative, steel sheet piling would be impracticable to place.
- 4. Exploratory trenches, three (3) feet deep and fifteen (15) inches wide in the form of an "H" with outside dimensions matching the outside of sheeting dimensions are to be hand dug, prior to placing and driving steel sheeting, in areas where railroad underground installations are known to exist. These trenches are for exploratory purposes only and are to be backfilled and compacted immediately. This work must be done in the presence of a railroad inspector.
- 5. Absolute use of track is required white driving sheeting adjacent to any track. Procedure for arranging the use of track shall be through the Railroad Company(s) representative on the project.
- 6. Cavities adjacent to sheet piling, created by driving of sheet piling, shall be filled with sand any disturbed ballast must be restored and tamped immediately as required by the Railroad Company(s).
- 7. Sheet piling shall be cut off at top of tie during construction. After construction and backfilling has been completed, the piling within twelve (12) feet from centerline of track will be cut off 24" below bottom of tie or 24" below finished grade, whichever is greater. Sheeting, used as a form on a permanent structure, will be cut as directed by the Railroad Company(s).

- 8. The excavation adjacent to the track shall be covered and protected by handrails and barricades, warning lights shall be provided by the Contractor as directed by the Railroad Company(s).
- 9. Graded backfill material shall be compacted at near optimum moisture content, in layers not exceeding 6 inches in compacted thickness, by pneumatic tampers, vibrator compactors, or other approved means to the base of the railroad subgrade. Material in the vicinity of sheet pile shall be compacted to not less than 95 percent of AASHTO T 99, Method C. The Contractor will be required to supply, to the job site, ballast stone as prescribed herein to be installed by the Railroad Company(s).
- 10. The Contractor is to advise the Railroad Company(s) of the time schedule of each operation and obtain approval of the Railroad Company(s) for all work to be performed adjacent to MBTA tracks so that it may be properly supervised by railroad personnel.
- 11. All drawings for temporary sheeting and shoring shall be prepared and stamped by a Registered Professional Engineer and shall be accompanied by complete design computations when submitted for approval.
- 12. Particular care shall be taken to avoid erosion or filling of the Railroad Company(s) drainage facilities. Erosion and sediment control in the vicinity of the railroad shall be as approved by the Chief Engineering Officer. Correction of disrupted Railroad Company(s) drainage facilities shall be at the Contractor's sole expense.

MBTA REQUIREMENTS FOR GEOTECH MONITORING

THE FOLLOWING SPECIFICATIONS ARE REQUIRED FOR ALL PILE DRIVING/EXCAVATING OPERATIONS:

- 1. Pile driving will be on a continuous basis for each pile driven. Once a pile is started, it will be driven or cut off at an elevation not to exceed the plane across the top of the rails of any track within 8'-6" plus 2" for each degree of curvature from centerline of track to the closest edge of the edge or excavation.
- 2. The monitoring points will be set up one week before the pile driving or excavation operations begin. The MBTA and the Railroad Company(s) shall he notified. Elevation readings to establish the initial baseline reading shall begin two days prior to the start of driving. Readings shall be for a minimum of two weeks after the completion of the driving or backfilling of the excavation, whichever is longer. Initial readings immediately after any surfacing operations shall serve as new baseline figures. All future elevation readings shall be compared to the adjusted baseline. If the track deviates to a condition acceptable to the MBTA or Railroad Company(s), corrections will be made at the proponent's expense.
- 3. Elevation readings will be taken from the top of each rail of each track within the "zone of influence" the excavation. See Section 1, Page 1 of this specification.
- 4. Elevation readings will be taken once per eight hour shift. The readings will be faxed to the MBTA Railroad Company(s) on a daily basis and all information is to be presented in <u>legible print</u>. During excavation within the sheet pile protected area, the top of rail elevations shall be checked every hour. Additional readings may be required by the MBTA or Railroad Company(s).
- 5. Stations shall be spaced at 15-1/2 foot intervals. The number distractions required will be determiner the length of the excavation parallel to the tracks. There will be four additional stations on each end of the pile driving/excavation operation along the track. Extra stations may be required by the MBTA or Railroad Company.
- 6. Elevation readings must show the date, time, weather conditions and temperature. Each reading must also provide the following information: track number, compass direction, station number, base elevation (with date), static elevation, change in elevation (recorded in hundredths and in inches), dynamic reading and total deflection in inches. See sample sheet attached.
- 7. Station "0" will be located at the centerline of the project with Stations 1, 2, 3, etc., being to the right and Stations -1, -2, -3, etc., being to the left when standing on the near track and looking at the work. In multiple track areas the stations as determined herein are to be carried across each track located within any part of the zone of influence. See Plate I.

- 8. At each monitoring station a dynamic loud measurement will also be taken. The dynamic load measurement device will consist of a wooden stake placed firmly in the ballast and in initially in contact with the bottom of the rail. The loaded measurement is the resultant gap between the bottom of the rail and the top of the stake caused by the deflection of the rail under the load of a passing train. Based on field observations of the excavation, and at the option of the MBTA or railroad company(s), this requirement may be reduced.
- Elevation readings taken from the top of rail for static measurement and the dynamic reading shall be combined and the sum compared to the adjusted baseline. This reading will demonstrate the difference in elevation caused by the excavation.
- 10. The MBTA requires that the track be maintained at all times within established criteria for the specific track classification. At the completion of the project the requirement for tamping and realigning the tracks, caused by the settlement from the construction activity, remains with the proponent for the duration as specified by the MBTA in their initial review of the work plans. This tamping and track realignment will be performed by the MBTA or railroad company(s) at the sole expense of the proponent.



VIII

BLASTING SPECIFICATIONS

Blasting on, over, under, within or adjacent to MBTA Railroad Property will be permitted only in special cases where it is demonstrated to the MBTA's Chief Engineering Officer that there is no practicable alternative to perform the work.

In such cases when blasting is permitted, the Contractor must submit a detailed blasting program to the MBTA and Railroad Company(s) for approval prior to the commencement of any work. The blasting program must contain the following information:

- a. Site plan with location of nearest MBTA structure.
- b. Plan of each blast showing hole spacing and delay pattern.
- c. Diameter and depth of each hole.
- d. Amount of explosives per hole.
- e. Total pounds of explosives per day.
- f. Total amount of explosives per blast.
- g. Type of non-electric delays to be used.
- h. Amount of stemming in each hole.
- i. Type of explosive to be used.
- j. Soil and rock profile in blast zone.
- k. Scaled distance to the nearest MBTA facility.
- I. Type and location of seismograph to be used.
- m. Size of blasting mats to be used.
- n. Safety precautions to be followed.

The following general requirements are to be adhered to:

- a. Obtain the services of a qualified vibration and blasting consultant to monitor the blasting.
- b. Use a non-electric detonation system whenever possible. If electric caps are used, a check must be made for stray currents, induced current and radio frequency energy to insure that this hazardous extraneous electricity is at an acceptable safe level.
- c. Provide an open face for maximum relief of burden.
- d. Limit the maximum peak particle velocity to 1 inch per second. Depending on existing conditions, this may be modified to 2 inches per second.
- e. Maintain an initial scale distance of 60 ft. per 1-1/2 lbs. After initial blasting, scale distance may be modified to a minimum of 50 ft per 1-1/2 lbs., if conditions permit.

Scale distance -- <u>Distance from blast to structure (in feet)</u>

Weight of explosives per delay (in pounds)

The contractor shall provide for a pro-blast and post blast survey, including photographs. An inspection of all nearby MBTA facilities shall be made to determine any changes that may occur due to blasting operations.

The contractor shall coordinate all blasting with the MBTA and Railroad Company(s) in advance to determine when the charges may be set. The contractor is advised that the MBTA and Railroad Company(s) use two way radios for train control. The radios operate in the 160 Mhz area. These radios cannot be turned off at any time.



IX

TEMPORARY PROTECTION SHIELDS FOR DEMOLITION AND CONSTRUCTION

The Railroad Company(s) will determine when and where protection shields are required. The designated construction of temporary protection shields must adhere to the following specifications:

- 1. The construction of temporary protection shields will be designed to prevent any dust, debris. concrete, formwork, paint, or tools from falling on MBTA Railroad Property below.
- 2. The temporary protection shields shall be erected prior to the start of work. The Railroad Company(s) will determine whether or not sufficient protection has been provided to perform the work over any particular area.
- 3. The temporary protection shields shall remain in place until all work over the railroad has been completed and shall be removed only when ordered by the Railroad Company(s).
- 4. To minimize the inconvenience to the users of any properties below and adjacent to the project, the Contractor will be required to complete the actual erection and removal of the temporary shields within time limits acceptable to the Railroad Company(s).
- 5. The erected temporary protection shields shall not infringe on any existing minimum vertical clearance.
- 6. The Contractor will be required to obtain the approval of the Railroad Company(s) before commencing any work beneath the shield. In certain areas, depending on the nature of the work, the Railroad Company(s) may require a specific method of protection.
- 7. The horizontal shield shall he designed to carry a live load of 100 pounds per square foot and a single concentrated load of 2,000 pounds located to produce maximum stress. The vertical shield shall be designed to carry a wide load of 30 pounds per square foot.
- 8. Prior to the start of construction, the Contractor will be required to submit the details of the temporary protection shield to the Railroad Company(s), who will review and approve the details only as to the methods of erection and as to whether or not the proposed installation will provide the level of protection required at the various locations. It is the Contractor's responsibility to design these protections so that they are in conformance with all existing laws, regulations and specifications that govern this type of work. Shield plans must include a material list and shall be designed by a Registered Professional Engineer. The drawings and calculations must bear his seal when they are submitted to the Railroad Company(s).
- 9. If during the actual construction, the Railroad Company(s) deems that the

shield is not providing the desired level of protection or that the Contractor has failed to properly maintain the shield, all work at the affected location shall cease until corrective measures acceptable to the Railroad Company(s) are instituted.

10. All temporary shields will be constructed using new material.





INDUSTRIAL SIDE TRACK SPECIFICATIONS

SECTION 1. GENERAL

All railroad track construction shall be performed under competent supervision of personnel experienced in railroad construction and shall conform to the standards of the MBTA. The MBTA and Railroad Company(s) will inspect and approve all side tracks prior to being put in service. This specification will be used for side tracks directly on or within 15 feet of the MBTA property line. Any construction outside of the MBTA property line will be in compliance with the standards of the serving freight railroad.

SECTION 2. MATERIALS

2.01 MATERIAL

Rails, ties, switches, frogs, etc. will conform with the standards of the MBTA for various types of turnouts and track installations thereby insuring replacement availability.

2.02 RAIL

The rails shall be 100# ASCE Section or of a heavier rail section in common use, new or relay. Relay rails shall not have more than 1/4" top wear measured vertically along center line of rail and not more than 3/8" side wear measured horizontally 3/4" below the normal top of rail. Rails shall be free from kinks, excessive rust and excessive head flow. Rails having line or surface bends that cannot be spiked will be rejected. Rail shall be free of internal defects. Rail used on the limits of MBTA Railroad Property shall be equal in weight and in section to the attached main line.

2.03 CROSS TIES

Cross ties shall conform to MBTA specifications, minimum size will be 7" x 8" x 8'6" and shall be treated with creosote in accordance with MBTA specifications. Relay ties may be approved after inspection by the MBTA and Railroad Company(s) prior to installation.

2.04 SWITCH TIMBER

Switch timber shall be new hardwood and conform to MBTA specifications 7" x 9" and of lengths required by MBTA standard turnout bill of materials. All timber shall be creosote treated as specified for cross ties. Relay timber as above.

2.05 TIE PLATES

Tie plates shall be new or relay at least 7-1/2" x 10-3/4", 1/2" thick, double shoulder and should be canted. Tie plates must conform to MBTA specifications. Damaged plates or plates showing more than 25% reduction in section due to corrosion or wear will be rejected.

2.06 JOINT BARS

Joint bars shall be new or relay, 100% toeless, 24" long or equal and conform to MBTA specifications. Relay bars must be free from appreciable wear. Joint bars shall have a minimum of four holes and the holes are to fit the punchings of the rail. Holes to have a clearance of 1/16". Joint bars that cannot be drawn up to give a tight fit will be rejected. No fewer than 4 bolts per joint will he allowed.

2.07 BOLTS, NUTS AND WASHERS

Bolts and nuts shall be new and of a size to fit the rail punchings. They shall conform to AREA specifications for low carbon steel track bolts and nuts. Washers shall be new spring type of appropriate size and shall conform to MBTA specifications.

2.08 TRACK SPIKES

Track spikes shall be 6" long, 5/8" square with an oval head and conform to MBTA specifications for soft steel track spikes. Tangent track will have at least 2 rail holding spikes per tie plate and all curves over 3" will have 3 spikes per tie plate.

2.09 BALLAST

Ballast shall conform to MBTA Material Specification 9248.

2.10 BUMPING POSTS

Bumping posts will be Hayes type, Durable "D" or equal, unless otherwise specified, and will conform to MBTA Material Specification 9206.

2.11 DERAIL

Type and quality of derail will be specified for each individual side track requirement. Derail will be connected into the railroad signal system. This will be performed by the Railroad Company(s) at the Owner's expense. Two pairs of insulated joints will be installed at a location to be determined by the MBTA. Side tracks with a descending grade toward the main track will require a split switch type derail.

SECTION 3. INSTALLATION

- 3.01 The track will be properly installed with a standard gauge of 4'8-1/2" except on sharp curves. In cases of sharp curves, gauge will be specified by the MBTA or the Railroad Company(s).
- 3.02 Ballast will be installed on top of subgrade for a depth of at least 6" below the bottom of tie and brought up to the top of the tie at the center and slope off to 1" below top of tie at the ends. It will then extend 1' beyond the end of the tie at that height, at which point it will slope off at a rate of 2:1 to the subballast.
- 3.03 Cross ties will be placed not more than 24" on center on tangent track and 19 ½" on center on curved track. When relay rails are used the unworn side will be placed on the gauge side. Tie plates will be installed on each cross tie. The center of the joint should he installed so as to be suspended by two ties.
- 3.04 It will be the responsibility of the builder of that portion of track designated as "property line to end" to connect to that portion of track designated as "clearance to property line" and provide the necessary joints or compromise joints with bolts as the weights of rail would dictate.

SECTION 4. BONDING

4.01 Where track bonding is necessary, it will be performed by the Railroad Company(s) in accordance with MBTA standards.

SECTION 5. APPROVAL

5.01 Plans for track installation must be approved by the MBTA and Railroad Company(s) before the design of the facility to receive rail service is finalized.

SECTION 6. CURVATURE OF TRACK

6.01 The recommended curvature shall be exceed 8° or less. The maximum allowable degree of curve is not to exceed 12° 30′, unless approved by the Chief Engineering Officer.

SECTION 7. GRADE OF TRACK

7.01 The maximum allowable grade for all tracks shall not exceed 1.5% descending towards mainline or 3% descending from mainline using 100 foot vertical curves.

SECTION 8. ELEVATION

Super elevation shall not exceed 1 inch.

SECTION 9. SUBGRADE

9.01 Subgrade will be prepared to a grade 18" - 20" below the proposed top of rail and shall be of a material that is compacted to 95% and provides for adequate drainage.

SECTION 10. ACCEPTANCE

- 10.01 Before track is placed into service to receive cars, it will be inspected and approved by a qualified track inspector from the MBTA, the Railroad Company, and the freight carrier.
- 10.02 No exceptions to these specifications are authorized without the written approval of the Chief Engineering Officer.



XI

RIGHT OF WAY FENCING SPECIFICATIONS

SECTION 1. GENERAL

1.01 DESCRIPTION

This section specifies the furnishing and installing of new Type I galvanized steel or Type II aluminum coated steel chain link fence. Right of way fence will be 6', 8' or 10' as required by site specific conditions.

1.02 SUBMITTALS

Shop Drawings

- 1. Include cross sectional dimension of posts, braces, rails, fittings, accessories and gate frames, design of gates, and details of gate hardware.
- 2. Include a layout drawing showing the spacing of posts and location of all gates, abrupt changes in grade, and all corner, gate, anchor, end and pull posts.

SECTION 2. PRODUCTS

2.01 MATERIALS

A. General

- Steel pipe dimensions and weights: ASTM A-53, Schedule 40 (except the hydrostatic testing requirement is waived). Dimensions specified are outside diameter (O.D.).
- Provide post with accepted semi-steel or pressed steel tops, so designed as to fit securely over post and carry top rail or spring tension wire; the base of post top fitting shall fit over the outside of post and shall exclude moisture from post. All fittings and accessories shall be hot dipped galvanized in accordance with ASTM A-53.
- B. Line Post: For all post heights, unless otherwise noted, Schedule 40, 2.375" O.D. pipe weighing 3.65 lbs./ft ASTM A-53 with a 2 oz. hot dipped galvanized coating shall be used.
- C. Gate post: Furnish post to support single gate leaf, or one leaf of a double gate installation, for the following gate widths:

Leaf Width	Gate Post	Sch. 40
up to 6'	2.875" O.D.	5.79 lb./ft
6 ['] to 12'	4.000" O.D.	9.11 lb./ft
12' to 18'	6.625" O,D.	18.97 lb./ft
18' to 32'	8.625" O.D.	28.55 lb./ft

D. End, Corner and Intermediate Posts

For all post heights, unless otherwise noted, Schedule 40, 2.875" O.D. pipe weighing 5.79 lbs./ft. ASTM A-53 with a 2 oz. hot dipped galvanized coating shall be used.

E. Top rail and Spring Tension Wire

- 1. Top Rail
 - a. Schedule 40, 1.66" O.D, pipe weighing
 2.27 lbs./ft. ASTM
 A-53 with a 2 oz. hot dipped galvanized coating.
 - b. Couplings and expansion sleeves: Outside sleeve type, minimum six inches long.
- 2. Spring tension wire: shall be marcelled (spiraled or crimped) #7 gauge (.177 inches) plus or minus 0.005 inches in diameter. ASTM A-824. 1.2 oz zinc per sq. ft.

F. Braces and Tension Rods

- 1. Compression braces: Same type and size as top rail.
- 2. Tension rods: 3/8" round rods with drop forged turnbuckles or other approved type of adjustment.

G. Fence Fabric

- 1. Type I galvanized steel ASTM A-392 Class 2 coating 2 oz.
 - a. Typical-2" diamond mesh 6 gauge (192") 2 oz.
 - b. Hot dipped galvanizing after weaving.
- 2. Type II aluminum coated steel ASTM A-491 size 2. 3/8" mesh.

- 3. Selvages: All types
 - a. Fabric shall be knuckled at both selvages.
 - b. Fabric over 60 inches high: knuckled at one selvage and twisted and barbed at the other.
- H. Fabric Bands, Brace Bands and Stretcher Bars
 - 1. Fabric Bands: 12 gauge pressed steel 7/8 inch wide.
 - 2. Brace Bands: 11 gauge pressed steel 1 inch wide.
 - 3. Stretcher Bars: 3/I6" x 3/4" galvanized steel.
- I. Tie wire and miscellaneous Items
 - 1. Tie Wire: Galvanized steel 6 gauge (.192") for post and rails.
 - 2. Hog rings: Galvanized steel 6 gauge (.192") for spring tension wire.
 - 3. Rail and Truss Cups: Galvanized semi-steel or pressed steel.
- J. Barbed Wire and Extension Arms
 - 1. Barbed Wire; ASTM Al21, 12-1/2 gauge, 4-point round barbs, Class 3 coating.
 - 2. Extension Arms: Projecting at an angle of approximately 45 degrees, fitted with clips or other means of attaching three strands of barbed wire, the top outside wire approximately 12 inches from the fence line and the other wires spaced uniformly between the top outside wire and the fence fabric.

K. Gates

- 1. General: Furnish gates complete with necessary hinges, latches, and drop bar locking devices; corners shall be welded or fastened and reinforced with suitable fittings.
- 2. All gates fabricated from 1.90" O.D. Schedule 40 pipe weighing 2.72 lbs./ft with a 2 oz hot dipped galvanized coating.
- L. Concrete: Class 2500 psi concrete consisting of aggregate passing the No. 8 sieve.

SECTION 3. EXECUTION

3.01 INSTALLATION

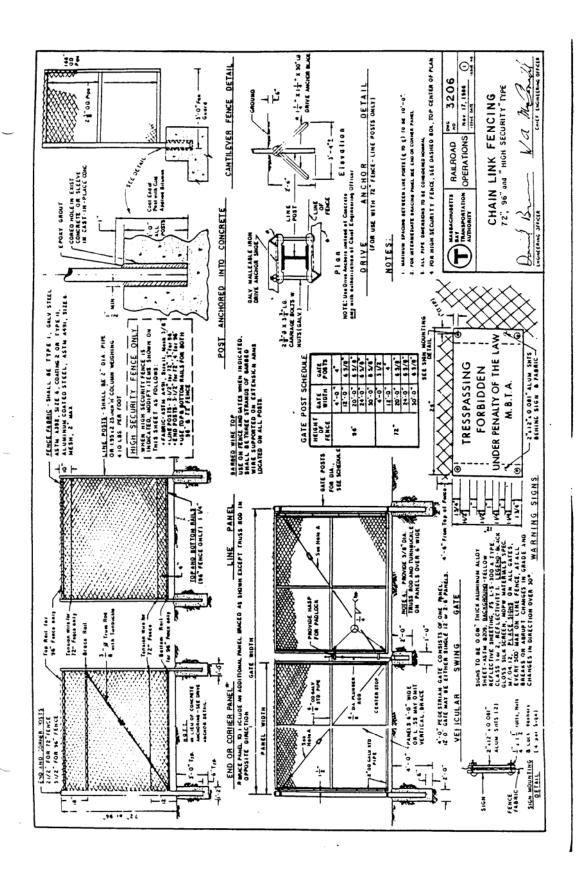
- A. Place terminal post at each end, corner, gate post, pull post (minimum 500'), or any change in grade or direction greater than 30 degrees.
- B. Line posts shall be spaced on a maximum of 10 foot centers. In determining the post spacing, measure parallel to slope of finished grade. All posts to be set plumb and in line. Post spacing on radius as follows:

200'- 500' radius 8' O.C. 100' - 200' radius 6' 0.C. less than100' radius 5' O.C.

- C. When fencing is installed on the top of concrete structures, use galvanized sleeve and grout posts or install with suitable galvanized flange casing and galvanized anchor bolts. Set all other posts permanently in concrete.
- D. Excavate post hole footings at least 12" in diameter for line post and 16" for terminal and gate posts up to 4" O.D. Larger gate posts require 18" diameter footings. All footings excavated to a depB1 of 42" with a minimum post embedment of 36". Crown top of concrete to shed water and allow to cure not less than 72 hours before proceeding with further work on the post.
- E. Brace end, corner pull, and gate posts to the nearest line post with diagonal or horizontal brace rails used as compression chambers, and with truss rods with turnbuckles used as tension members. Brace line posts horizontally and truss in both directions as required, at approved intervals.
- F. Install fabric on post side which best secures MBTA's Railroad Property. Pull fabric taut and tie to all line posts, rails, braces and spring tension wire spacing all ties at 12" intervals. Use hook shaped steel ties confined to the diameter of the pipe to which it is attached, clasping pipe and fabric firmly with both ends twisted at least 2 turns.
- G. Barbed wire and tension wire must be taut and properly secured with brace bands at each terminal and gate post.
- H. Electric Ground: Where a power line carrying more than 600 volts passes over fence, install ground rod at the nearest point directly below each point of crossing. Ground all substation fences and gates and perform other electrical grounding as indicated.

3.02 TOUCH-UP AND REPAIR WORK

Remove and replace fencing which is improperly located or is not true to line, grade and plumb within tolerances as indicated.





RAILROAD OPERATIONS DIRECTORATE

XII

TEST BORINGS SPECIFICATIONS

SECTION 1. GENERAL

All borings on MBTA Railroad Property are to be performed according to the following requirements:

- 1.01 Work on MBTA Railroad Property must be performed with a Railroad Company(s) inspector and/or flagman present.
- 1.02 Where access can only be gained by crossing the tracks, a temporary crossing must be used. This crossing shall adhere to the following:
 - A. The location and material must be approved in advance by the Chief Engineering Officer or Railroad Company(s).
 - B. The crossing will be constructed by Railroad Company(s) forces at the Contractor's expense.
 - C. The crossing must be protected at all times when not in use. Access will be prohibited through the use of right-of-way gates which will be constructed by Railroad Company(s) forces at the contractor's expense.
 - D. No crossing of the track shall be made without a railroad flagman and/or inspector present.
 - E. The crossing of tracks shall be kept to a minimum.
- 1.03 Boring locations, including positioning of the boring rig, shall be kept at least 8'6" from the center line of track.
- 1.04 All borings must be cased to insure adequate return (of mud and water) and to avoid undermining of the track.
- 1.05 All holes shall be backfilled with cement grout to fill the voids and protect against an artesian condition.
- The location of all utilities owned or private, shall be located and suitably marked by the Railroad Company(s) and/or the private owner at the Contractor's expense to avoid damage to the utility and/or track structure.
- 1.07 Prior to entry upon the MBTA Railroad Property, all necessary contracts, insurance policies and financial obligations shall be provided in a form acceptable to the Railroad Company(s).
- 1.08 Work within the operating right-of-way that has potential to foul the tracks, shall be restricted to periods of non-peak passenger operations.
- 1.09 While performing the work, full cooperation with the inspector and flagman is

essential. The work will be terminated immediately if the safety of all traffic and personnel is jeopardized in any way.

SECTION 2. TESTING

- 2.01 Soil borings shall be in accordance with the current issue of the American Railway Engineering Association Specifications, Chapter 1, Part 1, "Specifications for Test Borings". Soils shall be investigated by the split-spoon and/or thin-walled tube method and rock shall be investigated by the Coring method specified therein.
- 2.02 Soil boring logs shall clearly indicate all of the following:
 - 1. Boring number as shown on boring location plan.
 - 2. Elevation of ground at boring.
 - 3. Description or soil classification of soils and rock encountered.
 - 4. Elevations or depth from surface for each change in strata.
 - 5. Identification of where samples were taken and percentage of recovery.
 - 6. Location of ground water at time of sampling and, if available, subsequent readings.
 - 7. Natural dry density in lbs./sq. ft. for all strata.
 - 8. Unconfined compressive strength in tons/sq. ft. for all strata.
 - 9. Water content (percent). Liquid Emit (percent) and plastic emit (percent).
 - 10. Standard penetration in blows/ft.
- 2.03 Soil boring logs shall be accompanied by a plan drawn to scale showing location of borings in relation to the tracks, the elevation of ground surface at each boring, and the elevation of the top of rail of the tracks.
- 2.04 Soil investigation by auger, wash, or rotary drilling methods are not acceptable.
- 2.05 Borings shall be taken no more than two (2) feet from the field stake which marks the boring location. The stake should not be disturbed during boring operations. Lost stakes shall be reinstalled.
- 2.06 Unless a boring hole is actively being worked, it shall be securely covered or otherwise protected until permanently filled. When work at each boring hole is completed, the hole shall be properly filled.
- 2.07 Access to the boring locations must be approved by the Railroad Company(s). When possible, access shall be from public roads. Licenses for Entry, Insurance and Flag Protection must be obtained by the Contractor in accordance with all applicable MBTA Specifications.
- 2.08 Boring operations shall be confined to each boring location to the extent possible.

The contractor shall take necessary precautions to prevent damage to structures and facilities. The site shall be restored to a condition satisfactory to the Railroad Company(s).



RAILROAD OPERATIONS DIRECTORATE



FIBER OPTIC CABLE SPECIFICATIONS

SECTION 1. GENERAL

- 1.01 The purpose of the following standards is to provide basic information about the MBTA's requirements with respect to the design and construction of fiber optic cables on MBTA Railroad Property to fiber optic cable companies and their contractors.
- 1.02 All work performed on or affecting MBTA Railroad Property must be designed and constructed in accordance with the Commuter Rail Design Standards (Vol. I and II), MBTA Book of Standards, Railroad Operation Specifications and the following standards. Additional job specific requirements will be contained in the MBTA's Fiber Optic License Agreement and can be obtained by contacting:

Director of Real Estate Ten Park Plaza Boston, MA 02116

The Chief Engineering Officer or his designated representative will be responsible for the approval of all work. No modifications, changes or deletions will be made without his approval.

SECTION 2. PROJECT REVIEW AND COORDINATION

- 2.01 All plans and specifications shall be reviewed and approved by the MBTA and Railroad Company(s) prior to construction. The MBTA must approve the construction schedule and sufficient Railroad Company(s) personnel must be available before work begins.
- 2.02 If another fiber optic cable company has previous or exclusive rights along the proposed route, the alignment and cable location must be approved in accordance with existing agreements.
- 2.03 The fiber optic cable companies must coordinate the construction with others to minimize the disruptions to the MBTA railroad operations.

SECTION 3. CONDUCT OF WORK

3.01 In order to minimize the manpower requirements of the Railroad Company(s) and afford better control, supervision, and protection, the contractor will conduct his work sequentially and minimize the number of crews and their proximity. Crews should be confined geographically to an area that can be covered easily by a minimum number of Railroad Company(s) personnel. This can be accomplished by a block method of construction. A construction block will be used and is a 1-4 mile segment of right of way in which up to 3 fiber optic cable installation crews can work. The crews can work within the

construction block, but cannot work outside of it. The construction block must move as a unit along the right of way. The crews cannot work two blocks concurrently.

SECTION 4. CONSTRUCTION SCHEDULE

- 4.01 The fiber optic company or its contractor will submit a schedule of work to the MBTA for approval. The schedule will be based on methods of construction acceptable to the MBTA and Railroad Company(s). No work shall begin prior to approval by the MBTA.
- 4.02 Any changes or modifications to the schedule proposed by the fiber optic company or its contractor must be submitted to and approved by the MBTA prior to implementation. The MBTA, however, may be required to change or modify the construction schedule on account of its operations, maintenance requirements, or manpower shortages. In this event, the MBTA will give the fiber optic cable company as much advance notice as possible.
- 4.03 Construction schedules will be reviewed and updated every two (2) weeks or as required.

SECTION 5. ESTIMATE OF EXPENSES

5.01 An estimate of anticipated expenses will be provided based on durations provided by the fiber optic cable company or his contractor and construction schedules approved by the Railroad Company(s). Any changes in the schedule will cause the estimate to be revised. The fiber optic cable company or his contractor will be responsible for all of the costs incurred by the MBTA and Railroad Company(s) in support of the construction activities. This includes design review, engineering support, administration and supervision.

SECTION 6. BILLING

6.01 The fiber optic cable company or its contractor will be required to pay for railroad protective services in advance of costs incurred.

APPENDIX B

PART I: TEMPORARY PEDESTRIAN ACCESS ROUTE CHECKLIST

PART II: TEMPORARY PEDESTRIAN ACCESS ROUTE WORK

PROCEDURE

USED by	REV	DESCRIPTION		APPROVED
Design and Construction	0	Temporary Pedestrian Access Route Checklist # C2008-001	7-10-08	Draft
	U	Temporary Fedestrian Access Noute Checklist # 02000-001	7-10-00	Diait
Operations	1			
SMI	2			



TEMPORARY PEDESTRIAN ACCESS ROUTE CHECKLIST

CHECKLIST #C2008-001

Temporary Pedestrian Access Route:
 Does the Temporary Pedestrian Access Route have a 4' (48") minimum width and a 3' (36") minimum clearance to any free standing object or obstruction? Does the Temporary Pedestrian Access Route have a clear space of 5' (60") by 5' (60") at 200' intervals, used as passing areas? Does the Temporary Pedestrian Access Route have a firm and stable surface that is slip resistant?
Does the Temporary Pedestrian Access route comply with all slope, cross slope and curb ramp requirements as required in the MBTA Temporary Pedestrian Access Route Work Procedure?
Protruding Objects:
Are there any wall-mounted objects protruding more than four inches into the Temporary Pedestrian Access Route? Are there any overhead objects that project into the Temporary Pedestrian Access Route at a height of less than 80" from the ground surface?
Safety Barriers:
 Do safety barriers meet or exceed the requirements listed on the MBTA Temporary Pedestrian Access Route Work Procedure, WP2008 - 0003? Do safety barriers have a safety reflective surface and good color contrast? Are safety barriers 3' (36") high, secured, continuous to the ground, with a detectable edge at the bottom of the barrier that is at least 6" above the ground surface?
Signage:
Are there signs that direct pedestrians to the Temporary Pedestrian Access Route?
Are the signs accessible for pedestrians who are vision impaired or blind? Are there signs that explain what caused the disruption in the existing pedestrian route and provide an estimate of how long the disruption will last?
Lighting:
 Does the lighting over the Temporary Pedestrian Access Route meet or exceed the MBTA lighting criteria? Do light fixtures meet or exceed the MBTA Electrical criteria?
Any Comments:
SAFETY ACCESSIBLE PATH(S): Approve Deny
SIGNATURE: DATE:
POSITION:

USED by	REV	DESCRIPTION	DATE	APPROVED
Design and Construction	0	Temporary Pedestrian Access Route Work Procedure	7-29-08	Draft
Operations	1			
SMI	2			



TEMPORARY PEDESTRIAN ACCESS ROUTE WORK PROCEDURE

Work Procedure (WP)

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APPROVALS	DATE	TITLE				
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Overview

The MBTA must accommodate the needs of all pedestrians at work sites that encroach upon any existing pedestrian access route found on, in or near MBTA property such as; sidewalk, walkway, crosswalk, platform, station, etc. Pedestrian safety considerations, including consideration of equipment necessary to create a safe walkway around the job site for all pedestrians, must be included during job planning assessments and approval. The range of pedestrians varies greatly and includes parents with children, adults, seniors, and people with hearing, vision, mobility and cognitive disabilities; their needs are as diverse as the population they represent.

All pedestrians need protection from potential injury and must have a smooth, clearly delineated through or around a work area until the project is concluded. This work procedure ensures that employees create a temporary, alternate circulation path/pedestrian access route or accessible path of travel around job sites for all disrupted surfaces within the project scope.

This work procedure applies to any situation where MBTA work or free standing objects infringe or encroach upon the established pedestrian access route. Work sites where the work area encroaches upon a public right-of-way (sidewalk, walkway, or crosswalk area) and all work performed at, near or in MBTA facilities shall comply with these work rules. All altered portions of existing facilities located in the public right-of-way shall comply with these requirements to the maximum extent feasible.

If MBTA employees and contractors on a work site are unable to provide a 48-inch wide pedestrian access route through the worksite when conducting short-term work, they must ensure a safe, accessible route for pedestrians around the worksite, or close the sidewalk/platform/pedestrian access route to all traffic and direct pedestrians to an alternate pedestrian access route that maintains the 48-inch wide clear space requirement.

Governing Documents

MBTA Pedestrian Access Route Standard Document # S2008-0002, rev. 0, 7-2-08

Safety

To ensure safety, MBTA employees, contractors, suppliers and all others performing work on behalf of the MBTA must follow all applicable precautions and requirements in setting up temporary work area protection when encroaching on to the existing pedestrian access route, as described in the following documents:

Occupational Safety and Health Administration (OSHA)
Occupational Safety and Health Standards for the Construction
Industry (29 CFR Part 1926)
Federal Highway Administration (FHWA)
Manual of Uniform Traffic Control Devices (MUTCD)
Massachusetts Highway Department
Work Zone Safety Guidelines

Definition of Terms

Accessible. General term used to describe the degree to which a product (e.g., device, service, environment) is accessible by as many people as possible. Accessibility can be viewed as the "ability to access" the functionality, and possible benefit, of some system or entity.

Crosswalk. (Shall have the meaning in MUTCD Section 1A13.18).

Cross Slope. The grade that is perpendicular to the direction of accessible pedestrian travel. On a sidewalk, shoulder, or blended transition, it is measured perpendicular to the curb line or edge of the street or highway; on a curb ramp, it is measured perpendicular to the running grade or to flared sides of curb ramp on narrow sidewalks.

Curb Line. A line at the face of the curb that marks the transition between the curb and the gutter, street, or highway.

Curb Ramp. A perpendicular or parallel ramp and its landing that cuts through or is built up to the curb.

Danger Zone. An area where a dangerous condition exists in an established accessible pedestrian route that presents a danger to the public. Examples of these conditions include a missing or loose material in the floor surface or ceiling, work on escalators or where the accessible pedestrian route terminates where the danger exists. A danger zone is considered a work zone.

Detectable Warning. A surface feature of truncated dome material built in or applied to the walking surface to advise of an upcoming change from pedestrian to vehicular way.

Facility. All or any portion of buildings, structures, improvements, elements, and pedestrian or vehicular routes located in a public right-of-way.

Free Standing Object. Objects mounted on ground surface or free-standing posts or pylons. Includes floor mounted devices such as; fans, dehumidifiers, post mounted fans, heaters or other devices

MBTA Representative. The highest-ranking person assigned to represent the MBTA and monitor the progress of the work. This individual may be a Project Manager, Resident Engineer, Inspector, Facility Superintendent/Supervisor and Facility Foreman or other person as designated by the appropriate Assistant General Manager or Chief Operating Officer.

Path of travel. A continuous, unobstructed pedestrian access route.

Pedestrian. (Shall have the meaning in MUTCD Section 1A13.55).

Pedestrian Access Route. A continuous and unobstructed walkway within a pedestrian circulation path that provides accessibility.

Pedestrian Circulation Path. A prepared exterior or interior way of passage provided for pedestrian travel.

Public Right-of-Way. Public land or property, usually in interconnected corridors, that is acquired for or devoted to transportation purposes.

Running Slope. The grade that is parallel to the direction of travel, expressed as a ratio of rise to run or as a percent.

Sidewalk. The portion of a street between the curb line, or the lateral line of a roadway, and the adjacent property line or on private property easements that is intended for use by pedestrians.

Sign. Any device that communicates information to road users or pedestrians using a word or symbol legend. Traffic control signals, pavement markings, delineators, or channelization devices are not signs.

Walkway. The continuous portion of the pedestrian access route that is connected to street crossings by curb ramps or flushed transitions.

Work Zone. Any location where work is performed such as construction sites, repair sites, revenue service diversions, Right of Way (ROW) work, etc.

1.0 Detailed Procedure

1.1 Internal Communication and Training

Conduct the MBTA Temporary Pedestrian Access Route Work Procedure training as a supplement to the Right of Way Training conducted bi-annually on heavy/light rail and annually on commuter rail.

1.2 Pedestrian Considerations

MBTA employees and contractors who have obstructed an existing pedestrian access route must immediately create and maintain a continuous, unobstructed 48-inch wide Temporary Pedestrian Access Route adjacent to the work site, preferably parallel to the sidewalk or original pedestrian access route that has been obstructed.

1.2.1 Same-side travel is preferred over street crossings.

Close sidewalks to all pedestrian traffic only when a safe passage around the work site cannot be established.

- a. To the extent possible, MBTA employees, supervisors and contractors should work with businesses affected by sidewalk and pedestrian access route closures to accommodate schedules and/or provide access.
- **b.** When overhead work is conducted or if there is danger of objects falling into the temporary pedestrian access route, suitable overhead protection shall be provided to prevent injury. Covered pathways shall be designed by a professional engineer licensed in the State of Massachusetts. Overhead clearance must be a minimum of 80 inches high when measured vertically from the ground surface.

1.3 Temporary pedestrian access routes (General)

When planning for pedestrians in temporary traffic control zones, Temporary Pedestrian Access Route in stations, on platforms, streets, etc. include the following:

- **1.3.1** Pedestrians are not allowed into conflicts with work site vehicles, equipment, or operations.
- **1.3.2** Do not lead pedestrians into conflicts with vehicle traffic or work site vehicles or equipment.
- **1.3.3** When establishing a Temporary Pedestrian Access Route next to vehicular traffic, it is recommended that pre-cast concrete barriers be used along the vehicular side of the accessible path of travel.
- 1.3.4 Provide pedestrians with a convenient, safe, and accessible temporary pedestrian access route that replicates, as nearly as possible, the most desirable characteristics of the existing pedestrian access route or a fully accessible pedestrian access route.

- 1.3.5 Inform pedestrians about changes in the existing circulation path or pedestrian access route in a way that is readily understandable by all, including pedestrians with disabilities and those pedestrians who are blind or have low vision.
- 1.3.6 Avoid moving vehicles and equipment across the designated Temporary Pedestrian Access Route wherever possible. If vehicles and equipment must travel through the pedestrian access route, MBTA employees and contractors shall use flaggers to direct vehicle traffic.

Note: Determine pedestrian needs at each work site by obtaining approval for the MBTA Temporary Pedestrian Access Route Plan from the responsible MBTA executive such as: AGM, Chief Operating Officer or their designee before starting any work. Temporary traffic control zones must provide security and safety for pedestrians navigating past work sites, as well as provide consistent, unambiguous channels that maintain the desired temporary pedestrian access route.

- **1.3.7 Abrupt Changes:** The Temporary Pedestrian Access Route shall not have abrupt changes of more than ¼ inch in any direction in grade, elevation, or terrain. The cross slope of the temporary pedestrian access route shall not exceed 2%.
- 1.3.8 Width: The width of the Temporary Pedestrian Access Route shall be 48 inches (4 foot) wide minimum with a clearance of 36 inches (3 foot) minimum with any obstacle such as free standing objects, light poles, trees, fans, etc. along the path of travel. Every effort should be made to have a Temporary Pedestrian Access Route width of 60 inches (5 foot) to better accommodate two wheelchairs traveling in opposite directions.
- 1.3.9 Passing Spaces: For longer Temporary Pedestrian Access Route runs with less than 60 inches (5 foot) of width clearance, provide a passing space of 60 inches (5 foot) wide for a distance of 60 inches (5 foot). This additional passing space will provide space for 2 pedestrians in wheelchairs to pass without leaving the path of travel. Passing space shall be located in a level section of the temporary pedestrian access route.
- 1.3.10 Obstacles: Obstacles protruding into the Temporary pedestrian access route should be avoided. When obstacles protrude into the path of travel pedestrians who are blind or have low vision may not see the obstacles and collide with them. Care must be taken to prevent the possibility of a collision with an obstacle that protrudes into the path of travel. When objects project from walls (for example, telephones) with their leading edges between 27" and 80" above the finished floor, they shall protrude no more than 4 " into the path of travel. Free-standing objects mounted on posts or pylons may overhang a maximum of 12" from 27" to 80" above the ground or finished floor. Free standing objects include items such as fans, poles,

signage etc. All free standing objects that are placed in the pedestrian access route shall have the appropriate barrier placed around the entire base so the object is detectable by pedestrians who are blind or have low vision.

- 1.3.11 Danger Zones: Particular care shall be used in cases where a dangerous condition exists in the Temporary Pedestrian Access Route or when the path of travel terminates at the work zone. These conditions require sturdy barriers that are detectable by persons who are blind or have low vision and may be using a cane. The barriers shall have a high contrast color to alert the public of the danger zone.
- **1.3.12 Surface:** The surface of the Temporary Pedestrian Access Route shall be firm, stable and slip resistant.
- 1.3.13 Detectable Edging: A continuously detectable edge shall be provided throughout the length of the temporary pedestrian access route such that it can be followed by pedestrians using canes for guidance. The detectable edge shall protrude 6 inches minimum above the surface of the sidewalk or path of travel. For outdoor applications, the detectable edge should consist of a prefabricated or formed-in-place curbing or other continuous product that is placed along the surface of the sidewalk or path of travel. Detectable edge should be firmly attached to the ground or to the barrier. Adjacent sections of the detectable edge should be interconnected such that the edge is not displaced by pedestrian or vehicular traffic or work operations, to eliminate a potential trip hazard to pedestrians, workers, or other users.
- 1.3.14 Lighting: Temporary pedestrian access routes shall be well lit with 5-foot candles (54 lux) and comply with MBTA lighting criteria; electrical criteria to be provided by the Authority.

1.4 Pedestrian Ramps

Use approved ramp systems for jobs estimated to last more than 2 hours in areas where pedestrians cannot be diverted safely around a worksite using driveways or curb ramps.

- 1.4.1 Use approved curb ramps when pedestrians are diverted off the walkway and into the street parallel to the work site. Ramps must provide pedestrians with visual and mobility disabilities adequate transition from the sidewalk into the street. Ramps must be a minimum of 48 inches wide at tight turns or a minimum of 36 inches wide in straight path.
- **1.4.2** The running slope ratio must be a maximum of 1:12 with no construction tolerance (one inch rise/one foot run). Curb ramp or ramp system running slopes should be minimized wherever possible to improve accessibility (1:12 maximum, 1:13, 1:14 or better). When a ramp slope of 1:20 can be achieved no handrails are required.

- **1.4.3** Curb ramp and ramp system cross slope shall not exceed 2% when measured perpendicular to the direction of travel.
- 1.4.4 The rise for any ramp run shall be (30 in) maximum. Ramps shall have landings at the top and the bottom of each ramp run. Landings shall be the width of the ramp (minimum) and a length of 60 inches (5 foot) minimum.
- 1.4.5 Ramp runs with a rise greater than (6 in) shall have handrails. Handrails shall be provided on both sides of ramps. Top of gripping surfaces of handrails shall be (34 in) minimum and (38 in) maximum vertically above ramp surface. Handrails shall be continuous within the full length of each ramp run. Handrail gripping surfaces shall have an outside diameter of (1.25 inches) minimum and (2 in) maximum. Curb ramps are not required to have handrails.
- **1.4.6** All ramps must have smooth on and off transitions. Beveled edges or feathered/compacted asphalt or concrete prevent tripping and wheeled mobility device tipping accidents. No lip edges may exceed ¼ inch.
- **1.4.7** Locate ramps so that they do not project into vehicular traffic lanes.
- **1.4.8** To prevent against hazards, landings and ramps must have wheel guides or "curbing" around the sides 2 inches high (minimum).
- **1.4.9** Use barriers along temporary ramps. Top of barrier should not be at a level where they are confused with handrails.

Note: For a description of a typical ramp setup, refer to Attachment XX

1.5 Signage

All signs proposed for an MBTA work site must be submitted as part of the plan submittal and approved by the MBTA Representative prior to placement or installation. Place approved signs at intersections so pedestrians are not confronted with mid-block work sites that could cause pedestrians to skirt the temporary traffic control zone or make a mid-block crossing. Pedestrians infrequently retrace their steps to make a crossing. Consequently, ample advance sidewalk closure notice is important.

- **1.5.1** Use detour signs to direct all pedestrians to use the alternate pedestrian access route (see Attachment 2).
- 1.5.2 Communication and signage shall enable all pedestrians, including those with vision impairments, to be aware of the work site and intended repairs as soon as identification of the problem has been recognized by the MBTA; before the repair or construction work begins.
- **1.5.3** Braille, raised characters or audible information should be provided whenever text signs are used to communicate with pedestrians.

1.5.4 Technology that provides audible information to pedestrians who are blind or have low vision shall be used at work sites. A small broadcasting device that gives recorded instructions when activated by a motion sensor is one method of providing effective audible information to pedestrians who are blind or have low vision (see Attachment 3).

Note: Refer to the MBTA Pedestrian Access Route Requirements; rev 0, 7-1-08 for more details and techniques for moving pedestrians through work zones.

1.6 Barricades

Use barricades, also known as K-rails (pre-cast concrete barricades), in areas where the volume and speed of vehicular traffic is high. Barricades must have sufficient strength and low deflection characteristics to keep vehicles from intruding into the Temporary Pedestrian Access Route or work sites.

- **1.6.1** Avoid short, non-continuous segments because they increase the potential for serious injury to both vehicle occupants and pedestrians. Encourage the presence of blunt, leading ends (connector points at either end of a longitudinal barrier system).
- **1.6.2** Use appropriate flares on all upstream leading ends or protect them with properly installed and maintained impact attenuators.
- **1.6.3** When using barricades, ensure that adjacent segments are continuous and properly joined.

Note: If the alternate circulation path or Temporary Pedestrian Access Route is diverted into the street, use a typical barricade application such as jersey barriers between the alternate circulation path and the vehicular way.

1.7 Barriers

When worksites occupy or conflict with existing pedestrian access routes, separate and protect all pedestrian traffic using approved longitudinal barrier systems. Temporary barriers, when set up properly, provide pedestrians safe access around worksites. For a description of approved typical barriers, refer to Attachment 1

- **1.7.1** Install barriers in the following locations:
 - **1.7.1.1** Between the pedestrians access route and any adjacent construction site.
 - **1.7.1.2** If the alternate circulation path is diverted into the street, install barriers such as jersey barriers between the alternate circulation path and the vehicular way.
 - **1.7.1.3** Between the alternate circulation path and any protruding objects, including swing areas (compressors, back-hoes, excavators, materials, etc), drop-offs, or other hazards to pedestrians.

1.7.1.4 Around any free standing object (fans, etc.) that is placed in the Pedestrian Access Route or in the Temporary Pedestrian Access Route.

1.7.2 Barrier Specifications

- 1.7.2.1 Construction barriers shall be continuous, stable, and non-flexible. The barrier shall have a solid toe board, with its top edge 6 inches in height from the ground or walkway surface. The barrier shall have a height of 36 inches (3 foot) minimum from the ground or path of travel surface.
- 1.7.2.2 To provide proper support and stability, use bases at either end of each barrier and tie them at the top. In addition, when using a lightweight barrier, units that can be filled with sand/water for stability should be used whenever possible. Caution tape alone does not provide an adequate barrier and cannot be used to delineate the alternate circulation path or temporary pedestrian access route.
- 1.7.2.3 Create barriers from chain-link fences, plywood, or any other material that protects pedestrians without disrupting the pedestrian network. Do not use cones, unconnected "A-Frame" barriers, or connected A-Frame barriers that project into the path of travel. Do not use toe rails to direct pedestrian traffic. When using a continuous material such as plywood as the barrier there is no need to provide an additional detectable edge at the bottom of the barrier.
- 1.7.2.4 To protect pedestrians who are visually-impaired or blind and use a cane, barriers must have brightly contrasting colors marking each end as well as decision and turning zones along the Temporary pedestrian access route. In addition, a continuous detectable edge shall be provided along the bottom of the barriers 6-inch minimum above the ground or walkway surface running the entire length of each side of the barrier that.
- **1.7.2.5** Barrier support member must not protrude into the alternate circulation path or Temporary Pedestrian Access Route.
- **1.7.2.6** Use approved manhole barriers to warn pedestrians of an open vault.

1.8 Pedestrian Traffic Plates

Use trench plates with an appropriate amount of cold mix pack or similar to provide a smooth transition from the sidewalk or from the street to the plate. Use enough

cold mix pack or similar to prevent plate movement. If plates have the potential to move and cause a hazard, MBTA employees and contractors may also recess the plates into the Temporary pedestrian access route.

Note: Trench plates often have "lift holes" that enable a chain with a hook that is attached to a back-hoe to move the plates from a storage location to cover an excavation when work takes place during non-work hours. The "lift holes" pose a hazard to wheelchair users and ambulatory pedestrians. To avoid creating a tripping hazard while the plates are in the Temporary Pedestrian Access Route, plug lift holes with a suitable material, such as wood or plastic plugs.

1.8.1 Sturdy plywood or metal plates are acceptable for use when bridging construction sites only if the surface is continuous, stable, and has no gaps or inconsistent levels, including no lip edge facing the direction of travel that is greater than ¼-inch. Beveled edges or feathered/compacted asphalt or concrete prevent tripping and wheelchair tipping accidents.

Note: For trench plate specifications, refer to Attachment XX

1.9 Potential Hazards

- 1.9.1 During job site maintenance, do not store tools, equipment, or materials within the temporary pedestrian access route. Heavy equipment with protruding parts, including swing areas, must not be in the path of travel.
- **1.9.2** Remove snow or debris, and properly drain temporary pedestrian access routes.
- **1.9.3** During both working and non-working hours, clear sidewalks and pathways of debris, and provide pedestrians with a safe temporary pedestrian access route.

2.0 Work Plan Submittals

Submit a copy of the plan describing the means to establish, maintain and remove the Temporary Pedestrian Access Route at least 30 days prior to implementation of the work. Indicate the following:

- 1. Construction work zones
- 2. Pedestrian access routes and detours through and around each construction zone.
- 3. Directional signage and signage schedules showing graphics layout for primary and secondary exterior sign band, messages, interior secondary sign messages, and sign band directional arrows.
- 4. The planned use of dual mode signage (audible and visual) for effective communication.
- 5. Proposed and existing utilities within the temporary pedestrian access routes.

- 6. Materials used to construct or establish the temporary pedestrian access route.
- **2.1** Structural Information: Submit calculations for all loading conditions including impact load resistance for Pedestrian Covered Walkways, prepared, signed and stamped by a structural engineer registered in the Commonwealth of Massachusetts.
 - **2.1.1** Qualifications of Professional Engineer.
 - **2.1.2** Plan approved by MBTA Representative prior to start of work.

3.0 Work Plan Approval and Monitoring

Assistant General Manager (AGM) or Chief Operating Officer shall assign an MBTA Representative to approve the submitted plan and monitor the progress of work performed by an owner, contractor or other person(s) or entity. MBTA Representative is responsible for monitoring the progress of the work and assuring they following:

- **3.1** Owners, Contractors, or those establishing temporary accessible path of travel adhere to the requirements as defined in this document.
- **3.2** Approval of the Temporary Pedestrian Access Route plan prior to use.
- **3.3** Complete and submit the MBTA Temporary Pedestrian Access Route Checklist C2008-001.

4.0 Program Review

MBTA System-Wide Accessibility will perform an annual review with all MBTA departments that utilize this work procedure and update as needed the Temporary Pedestrian Access Route Work Procedure in conformance with the MBTA Technical Document Development Procedure. As part of this review, MBTA employees and contractors will be consulted as to work practice controls and the review will include an assessment of currently available engineering controls to ensure that the MBTA practices are consistent with current industry standards and best practice.

Attachment 1 – Barrier Examples





New Sentry 36" x 48" Barricade

Our New Sentry barricade is the most versatile barricade on the market and is approved by the Federal Highway Administration with an NCHRP-350 rating as a TL-1 Longitudinal channelizer (WZ-188)!

- 36" tall x 48" long makes quick work of any work zone or security perimeter.
- Low center of gravity and large capacity for ballast (100 gallons equals 884 lbs. of water) resists tipping and deflects vehicles.
- Threaded inserts molded into the barricade allow reflective 'rails', signs, sign or fence posts, or eye-bolts (sold separately) to be attached directly to the walls of the barricade.
- Patented vandal proof U-connectors in the bottom of the barricade create a continous line of protection.
- Compatible with 24" tall Minuteman barricades to create walls of varying height.
- Barricades nest and stack for shipping and storage.

NS 36x48 Org	New Sentry 36" x 48" Barricade	Orange	\$199.00	\$179.00	\$169.00	1	<u>Add</u>
NS 36x48 Wht	New Sentry 36" x 48" Barricade	White	\$199.00	\$179.00	\$169.00	1	<u>Add</u>

Mailing Address: The Traffic Safety Store PO Box 1449 West Chester, PA 19380

http://www.trafficsafetystore.com/SubCatMProdDetails.aspx?CID=10&SCID=38



Entrances: Plywood doors



Path of travel: Plastic barricades



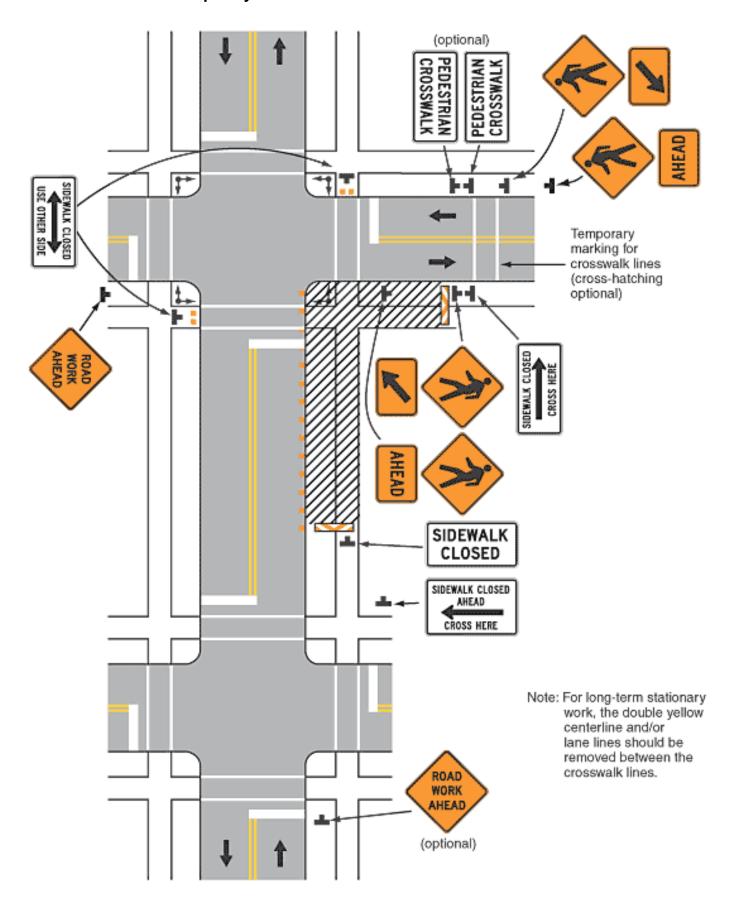
Portable ramp for curb transition into the temporary pedestrian access route



Safety barriers along both sides of temporary pedestrian access route



Plywood safety barrier protection along platform **Attachment 2 Signage**





Empco-Late Profile

CHIRP 350

Traffic Safety Products
Barricade Tubular 3V LED ADA Light B-Late Warning Work Zone Light Revolving Strobes Sequential Battery Holders

Safe Routes To School

Marine Safety Products Barge Lights Dredge Lights

Airport Lights

Emergency Flares Police Flare <u>Fire Flare</u> School Zone Flare

Golf Lights Railroad Lights

Customer Service Reps



Type A.D.A.* I & II Lights Meet requirements of Part 6D MUTCD

Model 400ML An Audible Information Device

Easily programmed for your message. Simply remove bottom to expose microphone, press record button and speak into microphone. Record up to a 20 second



Type "D" Flashing Light with 360 degree Warning Device and Beeper sound

Message may be customized for each location as needed.



Motion detector picks up walking pedestrian from fifteen feet away.



Туре А.Д.А. П Give positive guidance to visually impaired through temporary pathways with a unique "double" beeping sound.

Model 400MLType A.D.A. I Announces a clear audible message: "sidewalk closed, bus stop moved, and/or etc."

100 FT

Recommended Battery Cases

When crosswalks or other pedestrian facilities are

visually impaired and disabled through temporary

relocated, these units provide positive guidance for the



Model 400ML2CHolds two lantern batteries

Model 400ML4C Holds up to four lantern batteries

*A.D.A. Americans Disabilities Act of 1990, Title II, Par. 35.130

APPENDIX C

GEOTECHNICAL DESIGN REPORT, LABORATORY TEST RESULTS, BORING INFORMATION, MINI-PILE DESIGN RECOMMENDATIONS

C-i



Memorandum

343 Congress Street Boston, MA 02210 USA 1.617.242.9222 Fax 1.617.242.9824

Date March 30, 2009

To File

From Jennifer Jordan

Subject Fitchburg Commuter Rail Line Improvements Project

Geotechnical Recommendations for South Acton Station

Introduction

This geotechnical memorandum contains descriptions of the subsurface conditions encountered in the field exploration program, our recommended values for engineering properties and parameters of soil, and our recommendations regarding the geotechnical aspects of design and construction for the restoration of the South Acton Station for the Fitchburg Commuter Rail Line Improvement Project. Based on the 30% design documents, the extent of the structural renovations at the station consists of a new raised platform with a pedestrian ramp. The structures will consist of an approximate 750-foot-long, 18-foot-wide high level platform with a canopy structure located between the inbound and outbound tracks, as well as a pedestrian bridge from the platform to the existing parking area as shown in Figure 1.

Scope of Work

This memorandum was prepared by Jacobs Engineering Group in accordance with the scope of work under the contract between Jacobs Engineering Group and HNTB Corporation for work on the Fitchburg Commuter Rail Line Improvements Project, Massachusetts Bay Transportation Authority (MBTA) Contract #G67PS01. The Jacobs scope of work did not include environmental analyses to assess the potential presence of hazardous materials at the project site. The geotechnical work included the following tasks:

- Conduct and complete geotechnical investigation program;
- Report and interpret the results of the investigation; and
- Provide geotechnical recommendations for design of the project components.

Geotechnical Investigation

Jacobs Engineering Group planned the subsurface exploration program and retained the drilling contractor New Hampshire Borings Inc. to perform the exploration. Five borings were conducted at South Acton Station site as shown on the Subsurface Exploration Plans in Figure 1. All borings were supervised by an inspector from Jacobs Engineering Group. The soil and rock samples were classified in the field by the inspector and appropriate stratum breaks were interpolated from drilling and sampling observations. The final boring logs were then prepared by Jacobs Engineering Group, Inc. based on the field classifications, and can be found in Appendices A. The soil samples were classified in accordance with ASTM D-2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

The borings were drilled with a Diedrich D-90 truck-mounted drill rig. The borings were advanced through the soil by wash boring methods using a 4-inch casing and roller bit with water. Standard penetration tests (SPT), consisting of 140-pound hammer dropping 30 inches on a standard 2-inch diameter (OD) split-spoon sampler, were performed with a safety hammer to establish the consistency of the granular soils. The SPT's

were typically performed at five foot intervals of depth. The obtained samples were sealed in glass jars to retain their natural moisture. Two of the borings were advanced into bedrock using diamond-bit NX-size double tube core barrels. Core runs were 5 feet in length. Cores were placed in wooden core boxes for transport and storage.

Geotechnical boring logs performed in 1985, 1986, and 1994 by others for the nearby Main Street – Route 27 Bridge are included in Appendix C as additional information.

Subsurface Conditions

The subsurface profile along the cross section indicated in Figure 1 is presented in Figures 2. The subsurface profile was inferred from the boring data with some interpretations through the areas with missing information. The subsurface condition at the station site generally consists of fill, underlain by medium dense sand deposits of glacial or alluvial origin, overlying relatively shallow bedrock.

The fill layer typically consists of mostly granular sand and gravel fill with miscellaneous pieces of manmade materials such as coal/slag. The fill thickness is up to 6 feet thick. The fill density is typically medium dense with an average SPT N-value of 17 blows/foot. In many cases, it was difficult to distinguish between the fill and natural soils based on the sample descriptions, since the fill may have been obtained from local borrow pits. The natural soil deposits below the fill generally consist of predominantly sand with various gradations and with different gravel contents. These deposits are typically medium dense to very dense with an average SPT N-value of about 50 blows/foot. Although particularly difficult drilling conditions were not indicated in any of the boring logs, the occasional high N-values are generally caused by the presence of large pieces of gravel and cobbles or even boulders, which are common within this type of deposit.

Bedrock, which is predominantly gneiss, was encountered in the borings at elevations ranging from below Elevation 174 ft to as high as 197 ft. One unconfined compression test was conducted on a select bedrock sample from Boring SB-4. GeoTesting Express of Boxborough, MA conducted the test in accordance with ASTM D2938. The test results showing an unconfined compressive strength of 11 ksi are included in Appendix B.

Groundwater levels were measured in the test borings using a weighted tape at the completion of drilling. The data indicated the ground water level ranged from approximate El. 201.5 ft to El. 198 ft. The use of wash boring techniques may have artificially increased the water level readings due to the addition of water to the boring. Local and periodic variations of ground water elevations at any given point may also be influenced by local subsurface drainage, leaking water or sewer pipes, and precipitation. It is anticipated that groundwater is within 5 feet of the top of ballast at the station site.

Geotechnical Recommendations

Based on the subsurface profiles and preliminary station design information, the station platform and pedestrian overpass structure can be supported on shallow foundations bearing on top of either the medium dense to very dense sand deposit below the fill layer or the shallow bedrock. Due to constraints caused by the close proximity of the station platform to the active rail during construction, minipiles may provide a more constructable alternative to shallow foundations.

Shallow Foundations:

The bottom of footing should extend to a minimum of 4 feet below bottom of the ballast for frost protection. The footing subgrade should be over-excavated and replaced with a 1-foot-thick-minimum layer of

Jacobs Engineering Group Inc.

compacted structural fill. Any fine-grained soils, loose soils, or loose oversized rocks within the footing subgrade should be removed and all the voids backfilled with compacted structural fill. The structural fill material should be free from organic and other deleterious substances and should conform to the requirements listed in the MBTA Standard Specification Section 02200, Earthwork for Type B Gravel Borrow. The structural fill should be compacted to a dry density of 95% of the maximum dry density as determined by the Modified Proctor compaction test (ASTM D1557, method C). For foundation bearing directly on bedrock, excavation of bedrock or weathered rock will be required to form a level bearing surface. If soil is present in part of the foundation subgrade area, the soil should be over-excavated to the top of rock and replaced with crushed stone or lean concrete to create a level bearing pad.

The recommended allowable design bearing pressure for the footings bearing on the sand deposit is 3 tsf, and 80 tsf on bedrock, which will provide a minimum factor of safety of 3 against bearing failure and also limit the total settlement to less than one inch and differential to less than ½ inch. All footings should be at least 4 feet wide.

Based on the information from the borings, we expect the ground water levels at the station site is a few feet above the bottom of the footing excavations, and thus dewatering for footing excavations will likely be required. Therefore, the footing construction can be performed in open excavations with dewatering using filtered sumps. All temporary open cuts should be conducted in accordance with the related OSHA regulations and should have side slopes of no steeper than 1.5H:1V. We understand that the railroad tracks on the right-of-way will likely remain open during the station construction. To maintain the use of the tracks above the foundation excavations, the temporary excavation support should also be designed for E-80 train loading. The lateral pressure distribution model given in Figure 3 can be used to apply the surcharge for a train strip loading above and parallel to the wall.

Drilled Minipiles

As shown on the profile in Figure 2, the bedrock varies from about Elevation 187 ft to 197 ft along the station platform. If drilled mini-piles (DMP) are the preferred foundation type, the DMP's should be designed as small diameter cement-grouted friction piles extending 5 feet into bedrock. Based on the geotechnical conditions at the site, we have computed an allowable design load of 80 tons for a 9 5/8-inch outside diameter drilled mini pile, which include a factor of safety of 2.5 and 2.0 for end bearing and friction respectively. This capacity is based on friction and end bearing in bedrock only. The bearing capacity will generally be governed by the structural capacity of the pile. We estimate that the minipiles will vary in length from 10 ft to 22 ft. A load will be supported through end bearing and friction developed within the bedrock. Type B cement grouting is recommended per FHWA-SA-97-070 "Micropile Design and Construction Guidelines". If higher loads or greater lateral bending capacity is required, a permanent steel casing may be used.

Seismic Consideration

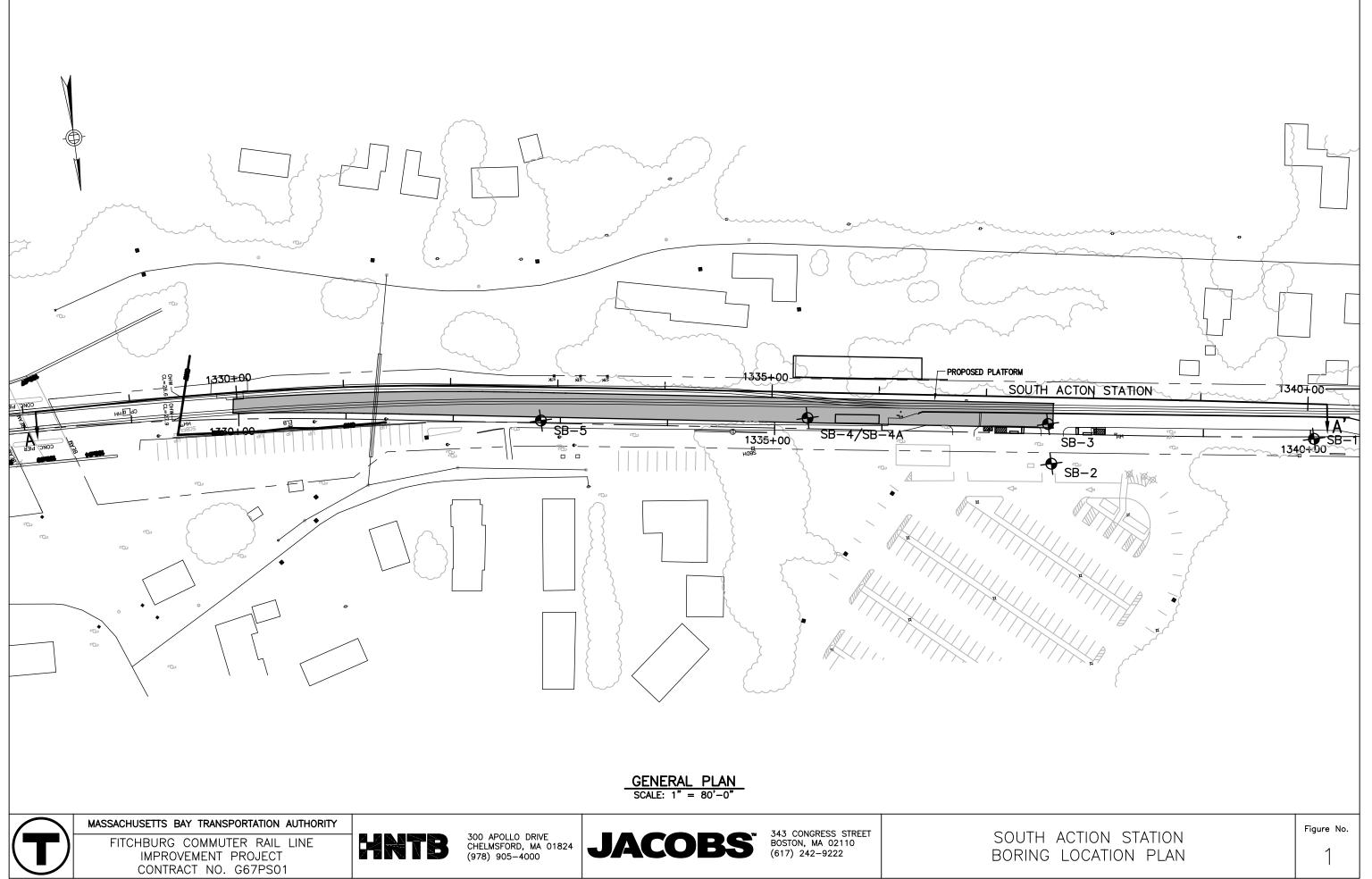
The seismic design of the platform structure should comply with the requirements of Section 1612.0 of the Massachusetts State Building Code and other relevant project design codes such as AREMA and AASHTO. Modification of the peak acceleration by the soils overlying bedrock depends upon the type of soil at the site. For the subsurface condition and foundation subgrades prepared according to our recommendations, the station site is classified as S1 soil profile, where the soil amplification of seismic base rock motions is not considered to be a problem because of the relatively high density of the soils. The structure could be designed for the total lateral seismic force using the equations specified in the code, or by the response spectrum method using the design spectra presented in the code. Furthermore, soil liquefaction is not a concern at the site because of the relatively high density of the foundation subgrades.

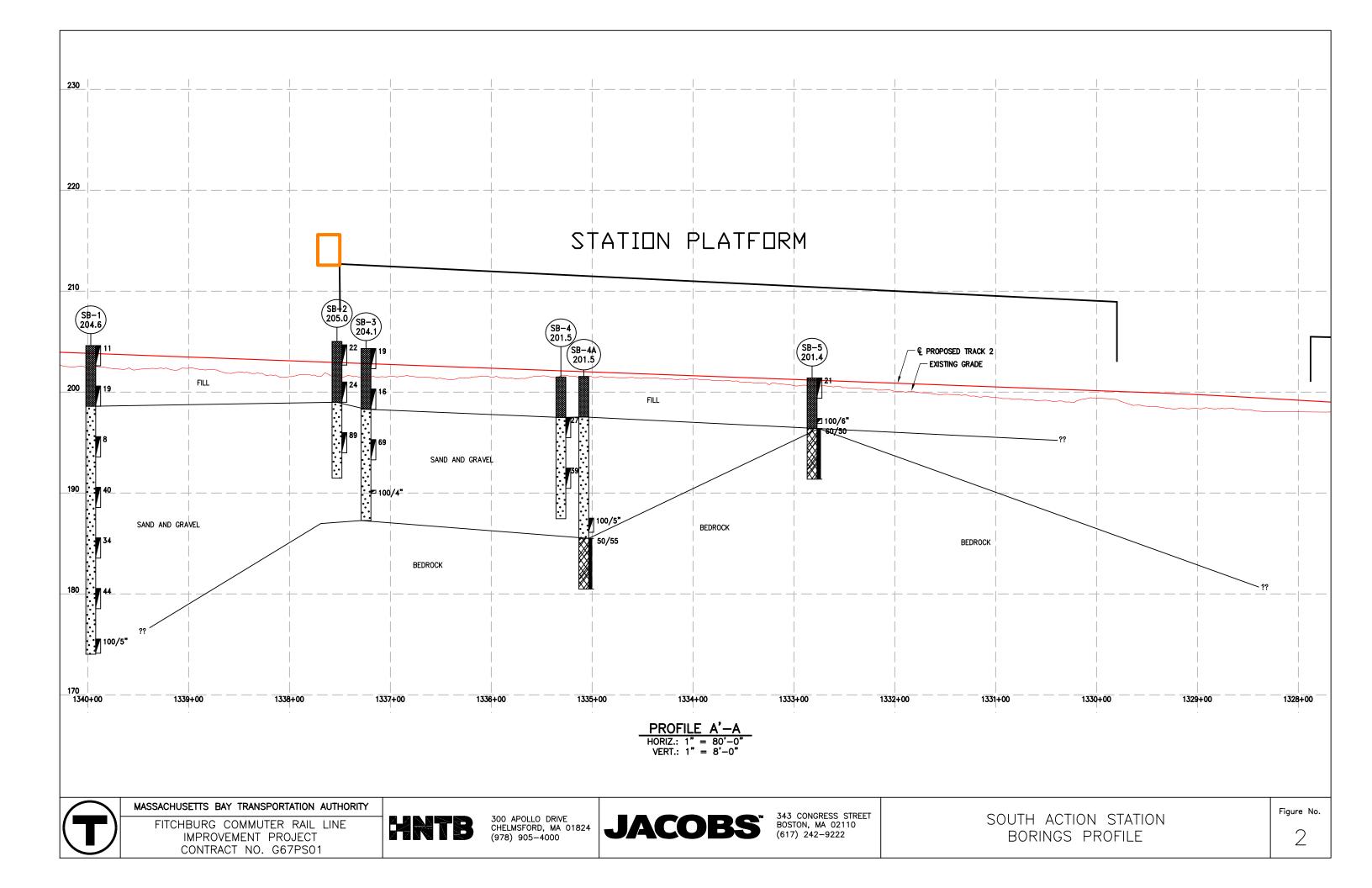
Memorandum

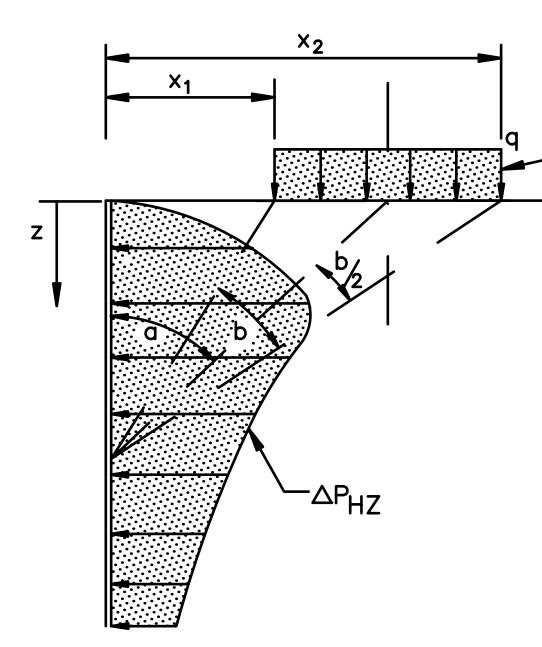


FIGURES

Figure 1: Boring Location Plan
Figure 2: Geotechnical Profile along Station Platform
Figure 3: Surcharge Pressure from a Strip Load







UNIFORM STRIP
LOAD - E80 LOADING

FOR RIGID WALL SYSTEMS:

$$\Delta P_{HZ} = \frac{2q}{TT} (b - \sin b \cos 2a)$$

FOR FLEXIBLE WALL SYSTEMS:

$$\Delta P_{HZ} = \frac{q}{\pi} (b - \sin b \cos 2a)$$

WHERE: a AND b ARE IN DEGREES AND RADIANS

$$b = \tan^{-1}\left(\frac{x_2}{z}\right) - \tan^{-1}\left(\frac{x_1}{z}\right)$$

$$a = \tan^{-1}\left(\frac{x_2 + x_1}{2z}\right)$$



MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

FITCHBURG COMMUTER RAIL LINE IMPROVEMENT PROJECT CONTRACT NO. G67PS01

Memorandum

APPENDIX A: BORING LOGS

SB-1

SB-2

SB-3

SB-4

SB-4A

SB-5

					PROJEC	NT		LOG OF	TEST BORI	NG		1	
					LOCATI			Acton Station			BORING		SB-1
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					JOB N		E2X378					SH	EET 1 OF 1
INSP	ECTOR	A. Barl	betta		CONTR			ampshire Boı	ing	DRILLER	D. Dunklee	ELEVATION	204.6
	METH	DD OF DR	ILLING			GRO	UNDWATE	r readings		DRILL RIG	Diedrich D-90	DATUM	Datum
0	Wash	Boring w/	/ 4" Cas	ina		DATE/TIME		DEPTH(ff)	REMARKS	SPT HAMMER	140 lb Safety	GRID	N 2992854
29	Split S	poon San	nple		11/6/2	8008		3	Upon Completic	on (In Casing)		COORD	E 667256
30.4	Spoon	Refusal										DATE STAI	
												DATE END	11/6/08
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15		²⁰ 24 ₁	SS:	-4 1	4 - 16	16		Poorty gi	raded sand (SF); mostly coarse	sand, trace gravel,	trace silt, gr	ay, wet.
20		7 20	SS 22	-5 1	19 – 21	14		Well grad trace cla	led sand with y, gray, wet.	gravel (SW): mos	itly fine to coarse so	and, little gra	vel, trace silt,
25		1725	SS 18	-6 2	24 – 26	4		Well grad gray, we		gravel (SW): mos	itly fine to coarse so	and, little gra	vel, trace silt,
30	0	6373	SS: 100/5*	-7 2 <u>9</u>	9 – 30.4	. 9	174.1	gray, we	!.		itly fine to coarse so	and, little gra	vel, trace sitt,
7F								Bottom o	f Hole at 30.4	•			
35	Page 1	: 0-35 feet.	Each subs	equent pa	ge displays	40 feet.							
co	HESIVE SO	a.	MON-	COHESIVE	SOIL		LATIVE				LEGEND		
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				191.5 -				o. Probabl	e Bedrock.			
							Totala di 10.0) . Probabi	le Bedrock.			
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		JOB NUI		E2X378	100		ı					OF 1 205.0
	35		M								<u> </u>	<u>-</u>
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LOG OF TEST BORING **PROJECT** Fitchburg Line Improvements SB-3**BORING JACOBS** LOCATION South Acton Station OWNER Massachusetts Bay Commuter Rail NO. SHEET 1 OF 1 JOB NUMBER E2X37800 INSPECTOR A. Barbetta CONTRACTOR New Hampshire Boring DRILLER D. Dunklee **ELEVATION** 204.1 METHOD OF DRILLING **GROUNDWATER READINGS** Diedrich D-90 DRILL RIG DATUM <u>Datum</u> DATE/TIME DEPTH(ff) SPT HAMMER 140 lb Safety N **REMARKS GRID** 2992808 Wash Boring w/ 4" Casing 17 11/10/2008 Jpon Completion (In Casing) COORD 667500 Spoon Refusal DATE START 11/10/08 11/10/08 DATE END SAMPLE SAMPLE DEPTH (ft) ELEV. DEPTH (ft) **STRATA** REC. (in) FIELD CLASSIFICATION AND REMARKS DATA SPT/RQD (%) Well graded sand with gravel (SW): mostly med to coarse sand, little gravel, brown, moist. SS-1 0 - 2 17 9 10 10 13₉ Well graded sand (SW): mostly med to coarse sand, trace gravel, trace silt, brown/black, wet. (FILL) $\$ 13 SS-2 5 7 198.1 0 0 82 40 0 9-9.2' Well graded gravel (GW): mostly med to coarse gravel. 9.2-10.3' Well graded sand (SW): mostly fine to med sand, trace gravel, trace silt, brown, SS-3 9 - 1115 10 0 0 0 100/4" -Weathered rock fragments. Spoon refusal at 14.5'. **SS-4** 14 - 14.3 2 15 -Casing and rotary bit refusal at 17'. (Probable Bedrock) 0 187.1 Bottom of Hole at 17'. 20 25 30 35 Page 1: 0-35 feet. Each subsequent page displays 40 feet. RELATIVE COHESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** Rect Core (RC) Semple (SS) Se OF SOIL COMPONENTS BLOWS/FT CONSISTENCY BLOWS/FT DENSITY VERY SOFT VERY LOOSE 0 - 20 - 4< 10% TRACE 15 - 25X UTTLE 11 - 30 31 - 50 SOME 5 - 8 MEDIUM STIFF MEDIUM DENSE 30 - 45%**BORING** SB-350 - 100% DENSE 9 - 15 STIFF 16 - 30 **VERY STIFF** 51 + VERY DENSE NO. 30 + HARD

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JAC	'OF	56 .	PROJECT LOCATIO		South A	irg Line Impi Acton Station			BORING		SB-	-4

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-30														
- 25							Bottom (of Hole at 21'.						
-20						180.5								
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-10														
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				PROJEC LOCATIO			ırg Line Imp Acton Statio				BORING	(R-	4A

						l	LOG OF	test Bori	NG					
				PROJEC			ırg Line Imp						<u> </u>	
_[A	COE	38	LOCATI			Acton Station				BORING		SB.	-5
								Commuter Rai			NO.		HEET	1 OF 1
INCD	ECTOR	A. Barbette	•	JOB NU		E2X378	ampshire Bo	dina .	DRILLER		unklee	ELEVATIO		201.4
ING		D OF DRILLIN		CONIK			R READINGS	····y	DRILL RI		rich D-90	DATUM	<u> </u>	Datum
)		oring w/ 4'			ATE/TIME	Ī	DEPTH(ff)	REMARKS	SPT HAI		lb Safety	GRID	N	2992743
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10	Termine	<u>rted</u>										DATE ST		11/7/08
			1									DATE ENI	<u> </u>	11/7/08
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10		•				191.4	Bottom o	of Hole at 10'.						
15														
20														
25														
50														
3 5	Page 1:	0-35 feet. Eacl	n subsequen	t page displays	40 feet.									
CO	HESIVE SOIL		NON-COHES	SIVE SOIL		ATIVE				LEGE	0			
.ows/1			WS/FT	DENSITY		ORTIONS COMPONENTS		per Nec	k Core (NC)	Spill-Speca Sample (35)	Undisturbed (U)—Shelby Tabe, (P)—Platon	¥	∇	Rag Sample (6)
0 - 2 3 - 4 5 - 8 9 - 1	L :	Y SOFT 0 SOFT 5 UM STIFF 11 STIFF 31	- 4 - 10 - 30 - 50	VERY LOOSE LOOSE EDIUM DENSE DENSE VERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRAC LITTL SOM MOST	E E		w L	⊣ per 6° NEC (h) ∟	BORING NO.		SB-	-

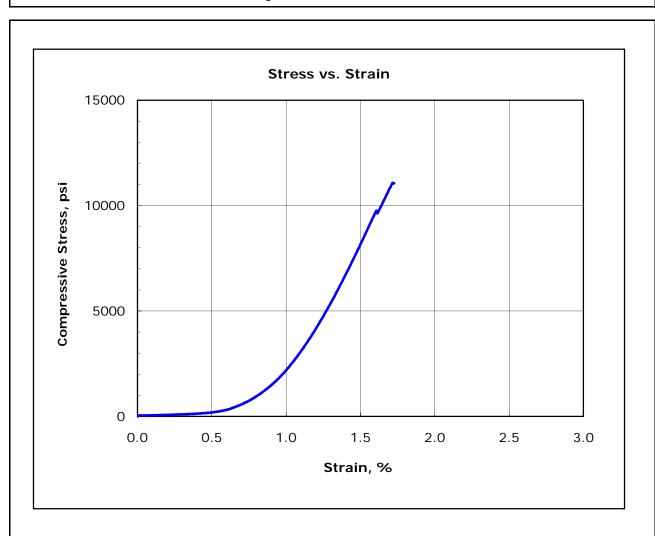
Memorandum

APPENDIX B: LABORATORY TEST RESULTS



Client:	Jacobs Civil, Inc.
Project Name:	Bakers Brook Bridge
Project Location:	Lunenburg, MA
GTX #:	8677
Test Date:	02/03/09
Tested By:	daa
Checked By:	mpd
Boring ID:	SB-4
Sample ID:	RC-1
Depth, ft:	16.0-21.0

Compressive Strength of Rock Core Specimens by ASTM D 2938





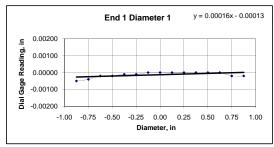
a subsidiary of Geocomp Corporation

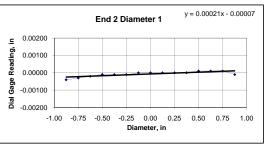
Client:	Jacobs Civil, Inc.	02/03/09	02/03/09	
Project Name:	Bakers Brook Bridge	daa	daa	
Project Location:	Lunenburg, MA	mpd	mpd	
GTX #:	8677			
Boring ID:	SB-4			
Sample ID:	RC-1			
Depth:	16-21 Ft.			
Visual Description:	Soo photographs			

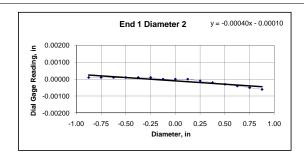
UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

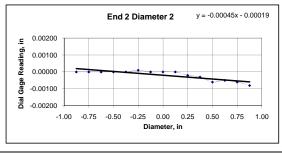
BULK DENSITY				DEVIATION FROM STRAIGH	ITNESS (Proced	lure S2)		
	1	2	Average		Max	Min	Difference	
Specimen Length, in:	4.07	4.07	4.070	Measurements at 0°, in	0.02260	-0.00380	0.02640	
Specimen Diameter, in:	1.95	1.95	1.950	Measurements at 120°, in	0.00830	-0.01540	0.02370	
Specimen Mass, g:	516.9			Measurements at 240°, in	0.00000	-0.02960	0.02960	
Bulk Density, lb/ft ³	162					Maximum differ	rence must be < 0.020 in.	
Length to Diameter Ratio:	2.09						Straightness Tolerance Met	? NO

END FLATNESS AND PARALL	ELISM (Proced	dure FP1)													
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00050	-0.00040	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00020	-0.00020
Diameter 2, in (rotated 90°)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00030	-0.00040	-0.00050	-0.00060
											Difference between	en max and m	in readings, in:		
											0° =	0.00050	90° =	0.00070	
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00040	-0.00030	-0.00020	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	-0.00010
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00000	0.00000	0.00000	-0.00020	-0.00030	-0.00060	-0.00050	-0.00060	-0.00080
											Difference between	en max and m	in readings, in:		
											0° =	0.0005	90° =	0.0009	
											Maximum differe	ence must be <	0.0020 in.	Difference = +	0.00045









DIAMETER 1			
End 1:			
	Slope of Best Fit Line Angle of Best Fit Line:	0.00016 0.00917	
	Angle of Best Fit Line.	0.00417	
End 2:	Slope of Best Fit Line	0.00021	
	Angle of Best Fit Line:	0.01203	
Maximum Angul	or Difformaco	0.00286	
Maximum Angul	ai Dillerence:	0.00266	
	Parallelism Tolerance Met?	VEC	
:	Spherically Seated	123	
DIAMETER 2			
End 1:			
	Slope of Best Fit Line Angle of Best Fit Line:	-0.0004 -0.02292	
	Angle of best Fit Line.	-0.02292	
End 2:		0.00045	
	Slope of Best Fit Line Angle of Best Fit Line:	-0.00045 -0.02578	
	5		
Maximum Angul	ar Difference:	0.00286	
	Parallelism Tolerance Met?	YES	
	Spherically Seated		

Flatness Tolerance Met?

YES

PERPENDICULARITY (Procedu	ure P1) (Calculated from End Flatness	and Parallelism me	easurements at	oove)		
END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?	Maximum angle of departure must be ≤ 0.25°
Diameter 1, in	0.00050	1.950	0.00026	0.015	YES	
Diameter 2, in (rotated 90°)	0.00070	1.950	0.00036	0.021	YES	Perpendicularity Tolerance Met? YES
END 2						
Diameter 1, in	0.00050	1.950	0.00026	0.015	YES	
Diameter 2, in (rotated 90°)	0.00090	1.950	0.00046	0.026	YES	



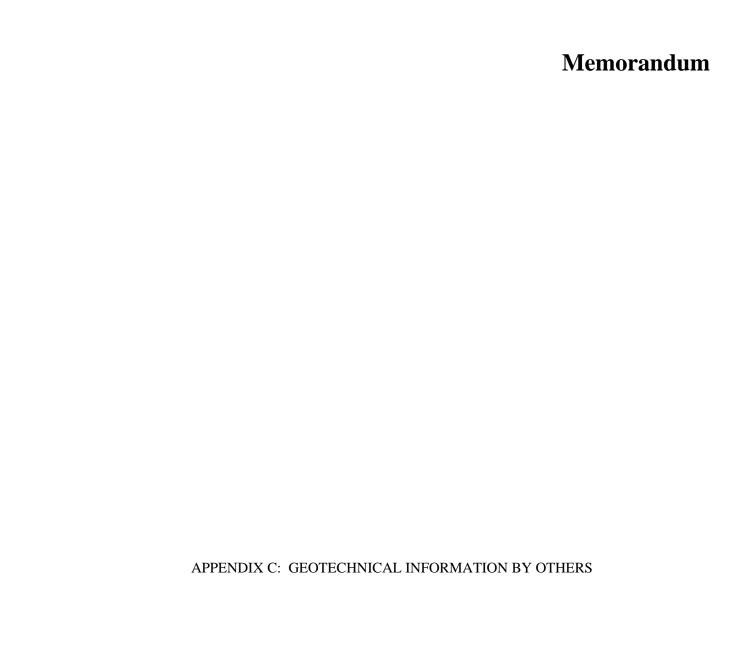
Client: Jacobs Civil, Inc. Project Name: Bakers Brook Bridge Project Location: Lunenburg, MA GTX #: 8677 Test Date: 02/03/09 Tested By: daa Checked By: mpd Boring ID: SB-4 Sample ID: RC-1 Depth, ft: 16.0-21.0

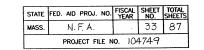


After cutting and lapping



After break





PLAN, PROFILE AND

GENERAL NOTES

SOUTH ACTON

MBTA/BLMRR

ISSUED FOR CONSTRUCTION

PROPOSED BRIDGE A-2-4

BRIDGE A-2-5

LOCUS PLAN

FOUNDATIONS MAY BE ALTERED, IF NECESSARY, TO SUIT CONDITIONS ENCOUNTERED DURING CONSTRUCTION, WITH THE APPROVAL OF THE ENGINEER. ALL UNSUITABLE MATERIAL SHALL BE REMOVED WITHIN THE LIMITS OF THE FOUNDATIONS OF THE STRUCTURE, AS DIRECTED BY THE ENGINEER. SEE HIGHWAY PLANS FOR LOCATIONS OF EXISTING AND NEW UTILITIES AND DRAINAGE.

BEARING ELEVATIONS SHOWN ARE THE ELEVATIONS OF THE BOTTOMS OF ELASTOMERIC BEARING PADS.

FOUNDATIONS

ALL STRUCTURAL STEEL SHALL CONFORM TO THE REQUIREMENTS OF THE A.S.T.M.: DESIGNATION A36. ALL STEEL SHALL BE GALVANIZED UNLESS NOTED OTHERWISE.

ALL REINFORCING STEEL BARS SHALL BE DEFORMED BARS CONFORMING TO THE REQUIREMENTS OF A.S.T.M.
A615 GRADE 60. UNILESS OTHERWISE SHOWN ON THE PLANS, ALL \$4 BARS SHALL BE LAPPED 26" AND
ALL \$5 BARS SHALL BE LAPPED 30", FOR HORIZONIAL BARS WITH 12" OR MORE OF CONCRETE BELOW THE
BAR, THE LAP LENGTHS SHALL BE 33" FOR \$4 BARS AND 42" FOR \$5 BARS. IF THE ABOVE BARS ARE
SPACED 6" OR MORE ON CENTER, THE LAP LENGTH SHALL BE 80% OF THE LAP LENGTH GIVEN ABOVE. ALL
OTHER BARS SHALL BE LAPPED AS SHOWN ON THE PLANS.

ALL REINFORCING BARS AND SUPPORT DEVICES SHALL BE EPOXY COATED, EXCEPT AS NOTED.

CONCRETE MIXES:

(2) (3) 1-1/2 1-1/2 0-3/4 0-3/4 4000 3500 4000 5000

565 520 610 635 (SILICA FUME MODIFIED)

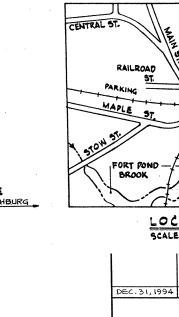
(1) 28-DAY COMPRESSIVE STRENGTH (PSI)
(2) MAXIMUM AGGREGATE SIZE (IN.)
(3) CEMENT CONTENT (LBS./C.Y.) CEMENT SHALL CONFORM TO AASHTO MATERIAL SPECIFICATION M85.

ADMIXTURES TO BE USED IN CONCRETE SHALL BE SUBJECT TO PRIOR APPROVAL BY THE ENGINEER.

all elevations given refer to ngvD (national geodetic vertical datum, formerly referred to as sea level datum of 1929).

BASELINE BOOK NO. 12680, DETAIL BOOK NO. 11508 AND CROSS-SECTION BOOKS NO. 26855 AND 42699.

USGS DISC # 34-A STA. 150 | 64.41, 25.8' LT., ELEVATION 219.36.



UTILITY BAYS MBTA-FITCHBURG MAIN LINE TO FITCHBURG

BARNES AND JARNIS, INC 25 STUART STREET BOSTON, MA

MAIN ST. - ROUTE 27 OVER M.B.T.A. COMMUTER RAIL

PROPOSED BRIDGE

ACTON

THE COMMONWEALTH OF MASSACHUSETTS MASSACHUSETTS HIGHWAY DEPARTMENT 10 PARK PLAZA BOSTON, MASS.

Oratur C. Daippulos

GENERAL NOTES

GENERAL

ALL DIMENSIONS, ELEVATIONS, AND DETAILS SHOWN FOR THE EXISTING STRUCTURE SHALL BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO ANY DEMOLITION OR RECONSTRUCTION. ANY DISCREPANCIES ON THESE PLANS WITH REGARDS TO FIELD DIMENSIONS OR CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER BEFORE PROCEEDING WITH THE AFFECTED PORTION OF WORK.

ALL DIMENSIONS SHOWN ON THE PLANS ARE HORIZONTAL AND ARE FOR THE STRUCTURE AT 68° F., UNLESS OTHERWISE NOTED.

THE CONTRACTOR'S ATTENTION IS DIRECTED TO THE FACT THAT, DUE TO THE NATURE OF THE RECONSTRUCTIC PROJECT, THE EXACT EXTENT OF THE RECONSTRUCTION WORK CANNOT ALWAYS BE ACCURATELY DETERMINED PRIOR TO COMMENCEMENT OF WORK. ACTUAL FIELD CONDITIONS MAY REQUIRE MODIFICATION TO CONSTRUCTION DETAILS. THE CONTRACTOR SHALL PERFORM THE WORK IN ACCORDANCE WITH FIELD CONDITIONS WITH PRIOR APPROVAL OF THE ENGINEER.

COMPLETE SHOP DRAWING AND SCHEDULES OF ALL TEMPORARY CONSTRUCTION, STRUCTURAL STEEL, PRECAST CONCRETE, REINFORCING STEEL SHALL BE PREPARED BY THE CONTRACTOR AND STRUCTURAL OF DITHE ENGINEER FOR APPROVAL PRIOR TO COMMENCEMENT OF THAT PORTION OF THE WORK. ACCESSORIES MUST BE SHOWN ON THE SHOP DRAWINGS. CALCULATIONS AND SHOP DRAWINGS SHALL BE STAMPED BY A PROFESSIONAL ENGINEER REGISTERED IN THE COMMONWEALTH OF MASSACHUSETTS.

THE CONTRACTOR'S ATTENTION IS DIRECTED TO THE FACT THAT THE COMMUTER RAIL TRAINS MUST REMAIN IN SERVICE DURING THE TIME OF RECONSTRUCTION.

IN ACCORDANCE WITH THE FIFTEENTH (1992) EDITION OF THE ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS SPECIFICATIONS AND INTERIMS, FOR HS20-44 LOADING.

SCALES NOTED ON THE PLANS ARE NOT APPLICABLE TO REDUCED SIZE PRINTS. DMIDE SCALES BY 2 FOR 1/4 SIZE PRINTS.

TRAFFIC MANAGEMENT

TO BOSTON

1327

TWENTY FEET MINIMUM OF ROADWAY WIDTH MUST BE KEPT OPEN TO TRAFFIC, AND 4 FEET 6 INCHES MINIMUM OF SIDEWALK WIDTH MUST BE KEPT OPEN TO PEDESTRIANS AT ALL TIMES DURING THE DEMOLITION AND CONSTRUCTION PHASES. SEE SHEET 5 FOR STAGE CONSTRUCTION.

PROFILE -

GRADE

CONSTR.

TOP OF RAIL ELEV. (RIGHT RAIL - INBOUND)

1329

The state of the s

1328

PROFILE OF MBTA AND B&M RR

HORIZ. 1"=40.0"

VERT- "= 8.0"

UNDER ROUTE 27

SCALE:

195' VC 205' VC V=25 MPH K=16.90 K= 17.74 V=20 MPH PVT STA. 154 +07.50 STA. 152+02. (TO BE REMOVED) EXISTING -PROPOSED. -+633 SILL 40 124 LT EL. 216-83 PROPOSED NORTH PIER HEIGH BRIDGE A-2-5 EXISTING (TO BE REMOVED NORTH ABUTMENT PROPOSED SOUTH PIER 212.7(Existing) EXISTING SOUTH ABUTMENT 7.0.7 215.8 845E 180 144 151 152 153

PROFILE OF ROUTE 27 (MAIN ST.)

STA. 151+22.49 ROUTE 27 4

STA. 1528+09.01 R.R. 4

OVER MBTA AND B&M RR

HORIZONTAL 1"=40.0" VERTICAL 1"= 8.0"

STA. 151+22.49 ROUTE 27 4 STA. 1328+09.01 R.R. 4

BG BIO // S // PROP IS' APP SLAB

R.R. (RAW.)

-PROP PIERS

- EXISTING MAIN LINE

KEY PLAN

SCALE: 1" : 40"

(TO REMAIN)

~ R.R (R.D.W.)

5

EX. NO. ABUTM'T. (TO REMAIN)

RAILR

153 MAIN ST. 154

#124

EXIST ABUTMENTS (TO BE REMOVED)

EXIST. BRA-2-5 (TO BE REMOVED)

R.R. (ROW) -

149 ROUTE 27

N 19 - 00'- 02"W

PROP. IS APP. SLAB-

PROPROSED SOUTH

ABUTMENT WINGWALL

RELOCATED SIDE TRACK

S

WGI Warren George Inc STATE FED. AID PROJ. NO. FISCAL SHEET TOTAL YEAR NO. SHEETS WGI Warren George Inc WGI Warren George Inc SUBSURFACE EXPLORATION 34 87 N.F.A. SUBSURFACE EXPLORATION HOLE NO: BB-14 LINE AND STATION: 151+36 OFFSET: 27' LT GROUND ELEVATION: 200.31 JOB LOCATION: Acton JOB LOCATION: Acton HOLE NO: BB-15 SUBSURFACE EXPLORATION PROJECT FILE NO. 104749 JOB LOCATION: Acton Route 27 (Main Street) over the MBTA and B&M Railroads Route 27 (Main Street) over the MBTA and B&M Rail BORING REPORT LINE AND STATION: 151+11 HOLE NO: BB-16 LINE AND STATION: 150+92 BORING REPORT the MBTA and B&M Railroads OFFSET: 27' RT GROUND ELEVATION: 200.11 BORING LOGS, INDEX & BRIDGE NO. A-2-4 MASSACHUSETTS HIGHWAY DEPARTMENT OFFSET: 27' LT GROUND ELEVATION: 199.01 BRIDGE NO. A-2-4 MASSACHUSETTS HIGHWAY DEPARTMENT CONTRACT NO. 93158 **ESTIMATED QUANTITIES** CONTRACT NO. 93158 MASSACHUSETTS HIGHWAY DEPARTMENT CONTRACT NO. 93158 DEPTH ON SAMPLER RATE RECOVER 9-6 6-12 12-18 MIN/FT % FIELD IDENTIFICATION OF SOIL FIELD IDENTIFICATION OF SOIL DEPTI-FEET Wet, dense, black COARSE to FINE SAND, some medium to fine gravel and cinc SAND, some fine gravel, ballast, wood 5 5-6.5 23 17 25 5-6.5 10 Boulder 9 to 12' 10 10-11.5 22 28 31 Wet, hard, gray INORGANIC SILT, some 8 14 42 Moist, hard, light brown INORGANIC SILT, some coarse to fine sand, trace fine gravel 15-16.5 Wet, very dense, brown FINE SAND. 15 15-16.5 30 29 31 20 20-21.5 C-1 20-25 20 20' Decomposed SCHIST Top of Bedrock 21-26 25' Decomposed SCHIST Top of Bedrock Gray Mica SCHIST and GNEISS 25 C-1 25-30 C-2 25 C-2 30 C-2 30 30 Bottom of Boring 30 ft 35 35 CHANGED LOCATION: Boring moved from 151+40, 27' LT to 151+36, 27' LT to avoid overhead wires. CHANGED LOCATION: Boring moved from 151+25, 27 RT to 151+11, 27 RT to avoid overhead wires. CHANGED LOCATION: WATER LEVEL: 2 IT 8/24/94 2:00 am
BORING STARTED: 8/24/94 1:30 am
BORING COMPLETED: 8/25/94 12:00 am
TOTAL HOURS: 6.5
DRILLER: E. Thomas
INSPECTOR: T. Conway WATER LEVEL: 2 II 8/24/94 1:00 am
BORING STARTED: 8/23/94 9:00 pm
BORING COMPLETED: 8/24/94 1:30 am
TOTAL HOURS: 4.5
DRILLER: E. Thomas
INSPECTOR: T. Conway SAMPLER TYPE: Spit Spoon SAMPLER OD: 2 in. II: 1.375 in. INSIDE LENGTH OF SAM*LER: 24 in. DIAMOND BIT SIZE: 1* X CASING ID: 4 & 3 in. 5 & 20 Ft WEIGHT OF HAMMEF: 140 Lb HAMMER FALL: 30 in. WATER LEVEL: 2 II 8/25/94 5:30 pm BORING STARTED: 8/25/94 2:00 pm BORING COMPLETED: 9/25/94 5:30 pm TOTAL HOURS: 3.5 CASING ID: 4 & 3 In. 5 & 25 Ft WEIGHT OF HAMMER: 140 Lb HAMMER FALL: 30 In. DIAMOND BIT SIZE: N CASING ID: 4 & 3 in. 5 & 21 Ft WEIGHT OF HAMMER: HAMMER FALL: 30 in. HELPER: D. Williams INSPECTOR: T. Conw WGI Warren George Inc SUBSURFACE EXPLORATION
Foot of Jersey Ave. Jersey City, N.J. HOLE NO: BB-17 LINE AND STATION: 150+70 OFFSET: 27' RT GROUND ELEVATION: 198.61 JOB LOCATION: Acton Route 27 (Main Street) over the MBTA and B&M Railroads **BORING REPORT** MASSACHUSETTS HIGHWAY DEPARTMENT CONTRACT NO. 93158 -INDICATES GROUND WATER ELEVATION (TYPICAL) PLAN INDEX SAMPLE NUMBER FIELD IDENTIFICATION OF SOIL SHEET NO. TITLE OF DRAWING Moist, dense, black FINE SAND, some Inorçanic silt, trace fine gravel KEY PLAN, PROFILES AND GENERAL NOTES **ESTIMATED QUANTITIES** Wet, very dense, light brown FINE SAND, some inorganic silt, trace fine gravel 5-6.5 13 24 29 BORING LOGS, INDEX AND ESTIMATED QUANTITIES (NOT GUARANTEED) STAGE CONSTRUCTION DETAILS DEMOLITION OF BRIDGE STRUCTURE NO. A-2-4 ----- 1.0 L.S. 19 74 for 5" 10-10.9 Moist, hard, light brown INORGANIC SILT, SOUTH ABUTMENT MODIFICATIONS DEMOLITION OF BRIDGE STRUCTURE NO. A-2-5 ----- 1.0 L.S. NORTH ABUTMENT MODIFICATIONS CLASS B ROCK EXCAVATION -----9.0 C.Y. WINGWALL AND ABUTMENT DETAILS Gray Mica SCHIST and GNEISS ABUTMENT AND SOIL ANCHOR DETAILS MOBILIZATION - DEMOBILIZATION OF SPECIAL C-2 20-25 100 PIER PLAN AND ELEVATION EQUIPMENT FOR DRILLED SHAFTS ----- 1.0 L.S. 25 PIER DETAILS CLASS I BITUMINOUS CONCRETE PAVEMENT TYPE I-1 ---- 29.0 TON CLASS I DENSE PROTECTIVE BINDER COURSE FOR BRIDGES -- 38.0 TON BEAM DETAILS OVER PIER 30 DECK PLAN AND ELEVATION TRANSVERSE SECTION AND DETAILS TEMPORARY BRIDGE NO. A-2-4T ---------------------------------1.0 L.S. 35 FRAMING PLAN AND DETAILS BRIDGE STRUCTURE NO. A-2-4 ----- 1.0 L.S. 16 - 20PRESTRESSED BEAM PLANS AND SECTIONS CHAI:GED LOCATION: 21 UTILITY SUPPORT AND MISCELLANEOUS DETAILS WATER LEVEL: 1.5 II 8/25/94 1:00 pm BORING STARTED: 8/25/94 9:30 am BORING COMPLETED: 8/25/94 1:30 pm TOTAL HOURS: 4.0 ORILLER: E. Thomas INSPECTOR: T. Conway SAMPLER TYPE: Split Spoon SAMPLER OD: 2 In. ID: 1.375 In. INSIDE LENGTH OF SAMPLER: 24 In 22 END POST DETAIL DEC. 31, 1994 ISSUED FOR CONSTRUCTION DATE DESCRIPTION DIAMOND BIT SIZE: NX 23-24 ANTI-MISSILE FENCE DETAILS USE ONLY PRINTS OF LATEST DATE CASING ID: 4 & 3 In. 5 & 15 Ft BRIDGE NO. A-2-4 SHEET 2 OF 24 SHEETS

WGI Warren George Inc

JOB LOCATION: Acton Route 27 over MBTA and B&M Railroads

TEST PIT REPORT

HOLE NO: TP-1 LINE AND STATION: North Abutment OFFSET: 3' East of Northwest Corner GROUND ELEVATION: 200.5

MASSACHUSETT'S HIGHWAY DEPARTMENT Bridge No. A-2-4

		CONTRACT N	0. 93158			Scale: 1"= 1.6"
DEPTH FEET		OF BRIDGE ABUT	MENT		FIELD IDENTIFICATION OF SOIL	DEPTH FEET
	First Mortar Joint Above Ground Level Used as Reference.					
-	_ GRANITE BLOCK			1'	Ground Level	
				1.6'	ORGANIC MATTER, ASPHALT and PEA GRAVI and FINE SAND	
2	Mortar Joint				Moist, loose, black FINE SAND, some inorganic silt, bricks, cobbles and railroad Iron	2
	GRANITE BLOCK				coopies and railroad from	
3						3
	Mortar Joint	0.7'		4.		
5	GRANITE BLOCK Mortar Joint Seepage Inrough Joint	0.4		Ī	Moist, very dense, light brown COARSE to FINE SAND and MEDIUM TO FINE GRAVEL, some inorganic silt, cobbies and boulders	
6	GRANITE BLOCK					6
	Bottom of Foundation			6.8		
					Bottom of test pit	
8	Note: Water seeped throu inch stream for several ho nearly continuous pumplr remove water from test pi	ours with	nalf			8
9						9
10		•				10

WATER LEVEL: 3' Below Ground Level 8/24/94 9:00 pm TEST PIT STARTED: 8/24/94 5:00 pm
TEST PIT COMPLETED: 8/24/94 9:30 pm
TOTAL HOUR 4.5
DRILLER: P. Gemeinhardt EXCAVATOR: INSPECTOR: T. Conway

WGI Warren George Inc SUBSURFACE EXPLORATION

JOB LOCATION: Acton Route 27 over MBTA and B&M Railroads

TEST PIT REPORT

HOLE NO: TP-2 LINE AND STATION: South Abutment OFFSET: 9' West of Southeast Corner GROUND ELEVATION: 198.6

MASSACHUSETTS HIGHWAY DEPARTMENT CONTRACT NO. 93158

DEPTH FEET DEPTH FEET DESCRIPTION OF BRIDGE ABUTMENT FIELD IDENTIFICATION OF SOIL GRANITE BLOCK 2 2 Mortar Joint Moist, loose, black FINE SAND, some inorganic silt, ballast, cobbles 3 Moist, very dense, light brown COARSE to FINE SAND and GRAVEL, some inorgobbles and boulders GRANITE BLOCK Mortar Joint Seepage through joint GRANITE BLOCK Bottom of Foundation 6 8 9 10 10 Bottom of test pit Note: Water seeped through joint in about half inch stream for several hours with nearly continuous pumping needed to remove water from test pit. 9

WATER LEVEL: 1.6' Below Ground Level #25/54 4:00 pm
TEST PIT STARTED: 8/25/94 2:00 pm
TEST PIT COMPLETED: 8/25/94 4:30 pm
TOTAL HOUR 2.5
DRILLER: P. Gemeinhardt EXCAVATOR: INSPECTOR: T. Conway

WGI Warren George Inc

CONTRACT NO. 93158

JOB LOCATION: Acton Route 27 over MBTA and B&M Railroads Bridge No. A-2-4

TEST PIT REPORT

HOLE NO: TP-3 LINE AND STATION: North Abutment OFFSET: 60' East of Northwest Corner GROUND ELEVATION: 200.9 MASSACHUSETTS HIGHWAY DEPARTMENT

DEPTH DESCI...
FEET First Mortar Joint Adove
Ground Level Used as
Reference. DEPTH FEET DESCRIPTION OF BRIDGE ABUTMENT FIELD IDENTIFICATION OF SOIL GRANITE BLOCK Bottom of foundation not determined.

Suppose through joint

Bottom of foundation not determined.

Note: Water seeped through joint in a steady stream. No pump available.
Test pit terminated due to soils from wait caving in. 5 6 7 7 8 9 9

WATER LEVEL: 2.1' Below Ground Level 8/23/94 11:00 pm TEST PIT STARTED: 8/23/94 9:30 pm TEST PIT STARTED: 8/23/94 9:30 pm
TEST PIT COMPLETED: 8/23/94 12:00 pm
TOTAL HOUR 2.5
DRILLER: P. Gemeinhardt EXCAVATOR: INSPECTOR: T. Conway

STATE FED. AID PROJ. NO. FISCAL SHEET TOTAL SHEETS 35 87 MASS. N.F.A. PROJECT FILE NO. 104749

BORING LOGS

ISSUED FOR CONSTRUCTION DEC. 31,1994 DESCRIPTION USE ONLY PRINTS OF LATEST DATE

SHEET 3 OF 24 SHEETS BRIDGE NO. A-2-4

STATE FED. AID PROJ. NO. FISCAL SHEET TOTAL YEAR NO. SHEETS 36 87 N.F.A. PROJECT FILE NO. 104749 **BORING LOGS** BORING NO. 6 BORING NO. 11 BORING NO. 10 BORING NO. 8 BORING NO. 13 BORING NO.7 BORING NO. 12 STA. 150 + 57 STA 150+62 STA. 150+72 151+31 STA. 151 + 40 STA. 151+52 STA. 151 + 58 LEGEND OFFSET 18'LEFT OFFSET 37'RIGHT OFFSET 5'LEFT OFFSET 68'RIGHT OFFSET 16 RIGHT OFFSET 43'LEFT OFFSET 5' RIGHT _____BORING IDENTIFICATION BORING NO. GROUND SURFACE ELEX-64287 - GROUND ELEVATION
FINE SAND
ROSE FLUIT GROUND SURFACE ELEV. 220.63 GROUND SURFACE BLOWS PER 6"ON SAMPLER UNLESS OTHERWISE NOTED 220 ASPHALT ELEV. 219.02 DESCRIPTION OF MATERIAL FILL PILL ROOK CORING TIME IN MINUTES PER POOT TOP OF ROCK 70'/ HARD GRAY ROCK SAND. GRAVEL SAND RUN 1 REC. 37 - LEDIGTH OF CORE
RECOVERED FROM (VERY FRACTURED 210 EXISTING NORTH ABUTMENT - 210 CORING RUN IDENTIFICATION NO. BOULDERS BOTTOM OF FOOTING ELEVATION 194' (ESTIMATED -- BOTTOM OF BORING EXISTING SOUTH ABUTMENT BOTTOM OF HOLE 80" FROM PROBE DATA) GRAVEL WATER LEVEL 5.5 AT COMPLETION HOLE STARTED 10-7-78 2:30 PM HOLE FINISHED 10-7-78 2:30 PM COMPLETION TIME BORNIG FOREMAN INSPECTOR BOTTOM OF FOOTING # PROPORTIONS USED IN SOLLS DESCRIPTION ELEVATION 194 (ESTIMATED FROM PROBE DATA) GROUND SURFACE GROUND SURFACE ELEV. 201.5 ELEV. 200.9 BORING NOTES ELEV. 200.6 200 FILL SAND, GRAVEL, SOME FILL - 200 GROUND SURFACE FILL GROUND SURFACE SAND SAND. LOAM. LOAM, ASPHALT PLEV. 198.7 ₩L, LOAN GRAVEL DENSE MEDIUM ALL ELEVATIONS ARE BASED ON THE NGVD MEAN SEA LEVEL DATUM OF 1929 MEDIUM DENSE TO FINE SAND, FILL LOAM & FILL LOAM & SAND VERY DENSE SAND VERY DENSE GRAVEL. SILT. WL. FINE TO Boring samples may be seen at the M.H.D., research and matls division, 99 worcester St., wellesley Hills, ma (intersection of Rt.9 & Rt.128) COARSE TO FINE 13 FINE SAND LITTLE BOULDERS VERY DENSE COARSE SAND SOME 18 DENSE FINE SAND, GRAVEL, ORINGS: WERE TAKEN FOR PURPOSE OF DESIGN AND SHOW CONDITIONS AT BORING DCATIONS ONLY, BUT DO NOT NECESSARILY SHOW NATURE OF MATERIALS TO BE INE SAND, LITTLE SOME GRAVEL INORGANIC SILT, BOULDERS. SAND. MED IUM SOME GRAVEL TRACE OF SILT LITTLE SAND & INORGANIC VERY DENSE igures in the right hand collinn indicate the number of blows red'd. O drive the 2° 3° 1.17 Sampler for 6 inches with a 140 pound animer pallung 30 inches, unless otherwise notied. INORGANIC SILT. MEDIUM DENSE INORGANIC SILT SILT GRAVEL PINE SILTY 190 LITTLE VERY DENSE FINE SAND DENSE DENSE FINE TO water levels shown on the boring logs were observed at the time of Taking Borings and do not necessarily show the true water level. VERY DENSE 21 26 SAND, GRAVEL, 34 FINE TO MEDIUM VERY DENSE FINE TO MEDIUM MEDIUM SAND WEATHERED ALL BORINGS WERE TAKEN IN AUGUST 1986 AND NOVEMBER 1985 SAND, SILT. SAND, GRAVEL FINE SAND, SOME GRAVEL. CARR-DEE CORP. 37 LINDEN STREET MEDFORD, MA ROCK VERY DENSE BORINGS WERE TAKEN BY VERY DENSE TRACE OF GRAVEL, INORGANIC FINE SAND, SOME INORGANIC SILT INORGANIC SILT INORGANIC SILT 26 DRILLED SILT WEATHERED ROCK LITTLE FINE SAND COBBLES SOME GRAVEL 100/4 WEATHERED ROCK 100/3" THE DEPTHS AS SHOWN ON THE ORIGINAL BORING LOGS HAVE BEEN CONVERTED TO ELEVITIONS BY THE ENGINEER. OR BOULDER BEDROCK OR BOULDER VERY DENSE 40 19 REFUSAL FINE SAND, LITTLE MEDIUM SAND (UNABLE TO ADVANCE 147 180 BEDROCK BOREHOLE UTILIZING ROLLER BIT) INORGANIC SILT 69 - REFUSAL-(100 BLOWS, S.S., 140-LB. WGT. - REFUSAL NO PENETRATION) (100 BLOWS, OER, 300-LB. WGT., NO PENETRATION) 4'0" 2'-9" WATER LEVEL : WATER LEVEL : WATER LEVEL : 3'-10" 3'-0" WATER LEVEL: 19'-6" WATER LEVEL : WATER LEVEL : 19-6" WATER LEVEL: 5'-0" 8-25-86 STARTED : 11-25-85 STARTED STARTED 8-28-86 STARTED 8-27-86 STARTED 8-26-86 STARTED 11-20-85 STARTED 8-25-86 FINISHED : 11-25-85 FILLISHED 8-25-86 8-29-86 FINISHED 8-28-86 FINISHED 8-27-86 FINISHED 11-21-85 FINISHED 8-25-86 FOREMAN : L.KNOX FOREMAN J. DESIMONE FOREMAN : J. DESIMONE FOREMAN J. DESIMONE FOREMAN J. DESIMONE FOREMAN : J. DESIMONE FORFMAN : D. DESIMONE INSPECTOR : M.DAVIDSON : K.PIDGEON INSPECTOR : M. HEALEY INSPECTOR INSPECTOR : K PIDGEON INSPECTOR K. PIDGEON INSPECTOR : K PIDGEON INSPECTOR : M.DAVIDSON 170 -- 170 (*) ASPHALT VERY DENSE (*) FINE SAND AND INORG. SILT (4) FINE SAND GRAVEL (#) MEDIUM DENSE FINE SAND FINE SAND, SOME GRAVEL, TRACE OF INORGANIC SILT (★*) DENSE FINE SAND & INORGANIC SILT (米米) MEDIUM DENSE FINE TO MEDIUM SAND ISSUED FOR CONSTRUCTION DEC. 31,1994 DESCRIPTION USE ONLY PRINTS OF LATEST DATE SHEET 4 OF 24 SHEETS BRIDGE NO. A-2-4



Memorandum

343 Congress Street Boston, MA 02210 USA 1.617.242.9222 Fax 1.617.242.9824

Date September 16, 2010

To File

From Alyssa Scenna

Subject Fitchburg Commuter Rail Line Improvements Project

Supplement to Geotechnical Recommendations for South Acton Station

Drilled Minipile Design Recommendations

Introduction

The following information is supplementary to the "Drilled Minipiles" section of the Geotechnical Recommendations for South Action Station issued in March of 2009 for the Fitchburg Commuter Rail Line Improvements Project. The previous drilled minipile design recommendation for the station platform is an 80 ton allowable design load for 9 5/8-inch outside diameter drilled minipiles which was computed relying on both end bearing and side friction. At 60% design, it was determined that smaller diameter minipiles may be used to support the platform. It is recommended that the allowable design load of the minipiles neglect end bearing capacity and rely only on skin friction for design as less pile movement is needed to develop frictional side resistance.

Drilled Minipiles

For construction considerations, micropiles are usually assumed to transfer their load to the ground through grout/ground skin friction (bond), without any contribution from end bearing. The advantage of this assumption is that the pile movement needed to mobilize frictional resistance is significantly less than that needed to mobilize end bearing. For piles bearing into bedrock, even though pile movement is relatively small, minpiles can still mobilize the majority of its calculated skin friction during loading process.

Based on the reviews of geological settings, and our split-spoon soil and rock core samples, it is our opinion that the skin friction within the first 5 feet of overburden soil zone should be neglected. We anticipate that the top 3 feet of bedrock is a moderately weathered gneiss zone, with competent gneiss bedrock below. We anticipate that the proposed station platform can be supported on minipiles by skin friction developed within the gneiss bedrock, with a minimum bond length (rock embedment length) of 5 feet. As shown on the profile in Figure 2, the bedrock varies from about Elevation 187 ft to 197 ft at the boring locations along the station platform. We estimate that the minipiles will vary in length from 10 ft to 22 ft.

Pile axial capacity can be determined considering the following design parameters, but not exceeding the structural capacity of the pile. If higher loads or greater lateral bending capacity is required, a permanent steel casing may be used. A factor of safety of 2.5 was used to determine the allowable bond strength of the minipiles in soil and a FS = 2.0 for bond strength in rock. Two different grout-to-ground bond strengths are recommended and are listed in the following table:



Memorandum

343 Congress Street Boston, MA 02210 USA 1.617.242.9222 Fax 1.617.242.9824

DEPTH (FT)	SOIL/ROCK TYPE	TOTAL * UNIT WEIGHT (PCF)	ALLOWABLE BOND STRENGTH (α) TYPE A** (PSI)	ALLOWABLE BOND STRENGTH (α) TYPES B OR D** (PSI)
0 to 5	Overburden	120		
Below 5	Dense Sand	125	5	8
Below Bedrock Surface	Gneiss	140	75	

Notes:

- 1) * Submerged unit weight should be used below a depth of 5 feet.
- 2) * To obtain the submerged unit weight, the total unit weight should be reduced by the unit weight of water (62.4 pcf)
- 3) ** Type A gravity grouted piles are usually used to bear into bedrock.
- 4) Per FHWA-SA-97-070 "Micropile Design and Construction Guidelines"

The allowable axial load of the minipiles for any diameter can be calculated using the following equation:

P_{G allowable} =
$$(\alpha_{\text{allowable bond strength}}) x (\pi) x (\text{diameter}) x (\text{bond length})$$

Field load testing should be performed for production minipiles. The pile load test program and proof tests during installation should be conducted as described in the project specifications. Testing procedures and results should be inspected and reviewed by the Engineer, and are subject to MBTA approval. In general, a tension load test should be designed in accordance with ASTM D3689.

APPENDIX D

ACTON CONSERVATION COMMISSION ORDER OF CONDITIONS



Massachusetts Department of Environmental Protection Bureau of Resource Protection - Wetlands WPA Form 5 - Order of Conditions

Provided by MassDEP: 85-1070

MassDEP File #

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

eDEP Transaction #
ACTON
City/Town

A. General Information		
1. From: ACTON		
Conservation Commission		
 This issuance is for (check one): a. ☑Ord	der of Conditions b. Amend	led Order of Conditions
3. To: Applicant:		
Holly	Palmgren	
a. First Name	b. Last Name	
Massachusetts Bay Transportation A	Authority	
c. Organization		
10 Park Plaza, Suite 6720		
d. Mailing Address	*	
Boston	MA	02116
e. City/Town	f. State	g. Zip Code
Property Owner (if different from application application as First Name) a. First Name	b. Last Name	
c. Organization		
d. Mailing Address		
e. City/Town	f. State	g. Zip Code
5. Project Location:		
4-8 Central Street	ACTON	
a. Street Address	b. City/Town	
H-2A	9	
c. Assessors Map/Plat Number	d. Parcel/Lot Number	
Latituda and Langituda if because	42 27'37.26"N	71 27'27.18"W
Latitude and Longitude, if known:	d Latitude	e Longitude



WPA Form 5 – Order of Conditions

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP:
85-1070
MassDEP File #
eDEP Transaction #
ACTON
City/Town

A. General Information (cont.)

6.	Property r	ecorded at the Re	aisti.	rv of	Deeds for (attach additional	info	ormation if more than
0.	one parce		gioti	y Oi	Doods for (attach additional		omation in more than
	Middlesex						
	a. County				b. Certificate Number	r (if	registered land)
	13117				113		
	c. Book				d. Page		
7.	Dates:	8/19/2011			September 7, 2011		September 7, 2011
1.		a. Date Notice of Inte			b. Date Public Hearing Close		c. Date of Issuance
8.)ther	r Do	cuments (attach additional pl	an	or document references
	as needed		-				
		Commuter Rail Lin	e Im	prove	ement Project Boston to Fitcht	our	g, MA - NOI Exhibit C
	a. Plan Title					_	
	HNTB Cor				Eric DiVirgilio, Pl		
	b. Prepared	-			c. Signed and Stamp	ed i	ру
	March 4, 2				1" = 40' e. Scale		
	d. Final Revi				e. Scale		
		er Management R Plan or Document Titl		rτ		_	a Doto
_					· "		g. Date
В.	Finding	gs					
1.	Findings p	oursuant to the Ma	assa	chus	etts Wetlands Protection Act	t:	
	Following	the review of the	abov	ve-re	ferenced Notice of Intent and	d b	ased on the information
					ented at the public hearing, t		
					is significant to the following	int	erests of the Wetlands
	Protection	Act (the Act). Ch	eck	all th	at apply:		_
a.	☐ Public	Water Supply	b.	\Box	Land Containing Shellfish	٥.	□ Prevention of □ Prevention of □ Prevention of □ Preventio
a.		rator cappry	٥.				Pollution
d.	☐ Privat	e Water Supply	e.	\boxtimes	Fisheries	f.	□ Protection of □ Protection of □ Protection of □ Protectio
				-			Wildlife Habitat
g.	⊠ Grour	ndwater Supply	h.	\boxtimes	Storm Damage Prevention i		
2.	This Comr	mission hereby find	ds the	e pro	pject, as proposed, is: (check o	one	of the following boxes)
Λn	proved sul	picat to:					
Aþ	proveu sui	ojeci io.					
a.	★ the fo	llowing conditions	whi	ch a	re necessary in accordance	with	the performance
					egulations. This Commissior		
	be perforr	ned in accordance	e wit	h the	Notice of Intent referenced	abo	ove, the following
					pecial conditions attached to		
					or differ from the plans, spec		
	proposals	submitted with th	e No	otice	of Intent, these conditions sl	nall	control.



WPA Form 5 – Order of Conditions

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP: 85-1070

MassDEP File #

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ACTON
City/Town

B. Findings (cont.)

Order.

De	nied because:
b.	the proposed work cannot be conditioned to meet the performance standards set forth in the wetland regulations. Therefore, work on this project may not go forward unless and until a new Notice of Intent is submitted which provides measures which are adequate to protect the interests of the Act, and a final Order of Conditions is issued. A description of
	the performance standards which the proposed work cannot meet is attached to this

- the information submitted by the applicant is not sufficient to describe the site, the work, or the effect of the work on the interests identified in the Wetlands Protection Act.

 Therefore, work on this project may not go forward unless and until a revised Notice of Intent is submitted which provides sufficient information and includes measures which are adequate to protect the Act's interests, and a final Order of Conditions is issued. A description of the specific information which is lacking and why it is necessary is attached to this Order as per 310 CMR 10.05(6)(c).
- 3. Suffer Zone Impacts: Shortest distance between limit of project disturbance and the wetland resource area specified in 310 CMR 10.02(1)(a)

a. linear feet

Inland Resource Area Impacts: Check all that apply below. (For Approvals Only)

Re	source Area	Proposed Alteration	Permitted Alteration	Proposed Replacement	Permitted Replacement
4.	Bank	a. linear feet	b. linear feet	c. linear feet	d. linear feet
5.	☐ Bordering Vegetated Wetland	a. square feet	b. square feet	c. square feet	d. square feet
6.	Land UnderWaterbodies andWaterways	a. square feet	b. square feet	c. square feet	d. square feet
		e. c/y dredged	f. c/y dredged		
7.	☐ Bordering Land Subject to Flooding	a. square feet	b. square feet	c. square feet	d. square feet
	Cubic Feet Flood Storage	e. cubic feet	f. cubic feet	g. cubic feet	h. cubic feet
8.	☐ Isolated Land Subject to Flooding	a. square feet	b. square feet		
	Cubic Feet Flood Storage	c. cubic feet	d. cubic feet	e. cubic feet	f. cubic feet
9.	☐ Riverfront Area	a. total sq. feet	b. total sq. feet		
	Sq ft within 100 ft	c. square feet	d. square feet	e. square feet	f. square feet
	Sq ft between 100- 200 ft	a. square feet	h. square feet	i. square feet	j. square feet



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B. Findings (cont.)

Coastal Resource Area Impacts: Check all that apply below. (For Approvals Only) Proposed Permitted Proposed Permitted Alteration Alteration Replacement Replacement 10. Designated Port Indicate size under Land Under the Ocean, below Areas 11. \quad Land Under the Ocean a. square feet b. square feet c. c/y dredged d. c/y dredged Indicate size under Coastal Beaches and/or Coastal Dunes **Barrier Beaches** below cu yd cu yd ☐ Coastal Beaches a. square feet b. square feet d. nourishment c. nourishment cu yd cu yd ☐ Coastal Dunes a. square feet b. square feet d. nourishment c. nourishment Coastal Banks b. linear feet a. linear feet 16. Rocky Intertidal a. square feet b. square feet Shores 17. Salt Marshes a. square feet b. square feet c. square feet d. square feet ☐ Land Under Salt a. square feet b. square feet **Ponds** c. c/y dredged d. c/y dredged 19. Land Containing b. square feet a. square feet Shellfish c. square feet 20. Fish Runs Indicate size under Coastal Banks, Inland Bank, Land Under the Ocean, and/or inland Land Under Waterbodies and Waterways, above a. c/y dredged b. c/y dredged 21. \quad Land Subject to Coastal Storm a. square feet b. square feet

Flowage



has been

entered in Section B.5.c (BVW) or

B.17.c (Salt

please enter

the additional

Massachusetts Department of Environmental Protection Bureau of Resource Protection - Wetlands

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B. Findings (cont.) * #22. If the 22. Restoration/Enhancement *: project is for the purpose of restoring or a. square feet of BVW b. square feet of salt marsh enhancing a wetland resource area 23. Stream Crossing(s): in addition to the square b. number of replacement stream crossings a. number of new stream crossings footage that

C. General Conditions Under Massachusetts Wetlands Protection Act

The following conditions are only applicable to Approved projects.

- Marsh) above, 1. Failure to comply with all conditions stated herein, and with all related statutes and other regulatory measures, shall be deemed cause to revoke or modify this Order.
- The Order does not grant any property rights or any exclusive privileges; it does not amount here. 2. authorize any injury to private property or invasion of private rights.
 - 3. This Order does not relieve the permittee or any other person of the necessity of complying with all other applicable federal, state, or local statutes, ordinances, bylaws, or regulations.
 - 4. The work authorized hereunder shall be completed within three years from the date of this Order unless either of the following apply:
 - a. the work is a maintenance dredging project as provided for in the Act; or
 - b. the time for completion has been extended to a specified date more than three years, but less than five years, from the date of issuance. If this Order is intended to be valid for more than three years, the extension date and the special circumstances warranting the extended time period are set forth as a special condition in this Order.
 - 5. This Order may be extended by the issuing authority for one or more periods of up to three years each upon application to the issuing authority at least 30 days prior to the expiration date of the Order.
 - 6. If this Order constitutes an Amended Order of Conditions, this Amended Order of Conditions does not extend the issuance date of the original Final Order of Conditions and unless extended in writing by the Department. the Order will expire on
 - 7. Any fill used in connection with this project shall be clean fill. Any fill shall contain no trash, refuse, rubbish, or debris, including but not limited to lumber, bricks, plaster, wire, lath, paper, cardboard, pipe, tires, ashes, refrigerators, motor vehicles, or parts of any of the foregoing.
 - 8. This Order is not final until all administrative appeal periods from this Order have elapsed, or if such an appeal has been taken, until all proceedings before the Department have been completed.



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C. General Conditions Under Massachusetts Wetlands Protection Act (cont.)

- 9. No work shall be undertaken until the Order has become final and then has been recorded in the Registry of Deeds or the Land Court for the district in which the land is located, within the chain of title of the affected property. In the case of recorded land, the Final Order shall also be noted in the Registry's Grantor Index under the name of the owner of the land upon which the proposed work is to be done. In the case of the registered land, the Final Order shall also be noted on the Land Court Certificate of Title of the owner of the land upon which the proposed work is done. The recording information shall be submitted to the Conservation Commission on the form at the end of this Order, which form must be stamped by the Registry of Deeds, prior to the commencement of work.
- 10. A sign shall be displayed at the site not less then two square feet or more than three square feet in size bearing the words,

"File Number 85-1070	,,
"Massachusetts Department of Environmenta	al Protection" [or, "MassDEP"]

- 11. Where the Department of Environmental Protection is requested to issue a Superseding Order, the Conservation Commission shall be a party to all agency proceedings and hearings before MassDEP.
- 12. Upon completion of the work described herein, the applicant shall submit a Request for Certificate of Compliance (WPA Form 8A) to the Conservation Commission.
- 13. The work shall conform to the plans and special conditions referenced in this order.
- 14. Any change to the plans identified in Condition #13 above shall require the applicant to inquire of the Conservation Commission in writing whether the change is significant enough to require the filing of a new Notice of Intent.
- 15. The Agent or members of the Conservation Commission and the Department of Environmental Protection shall have the right to enter and inspect the area subject to this Order at reasonable hours to evaluate compliance with the conditions stated in this Order, and may require the submittal of any data deemed necessary by the Conservation Commission or Department for that evaluation.
- 16. This Order of Conditions shall apply to any successor in interest or successor in control of the property subject to this Order and to any contractor or other person performing work conditioned by this Order.
- 17. Prior to the start of work, and if the project involves work adjacent to a Bordering Vegetated Wetland, the boundary of the wetland in the vicinity of the proposed work area shall be marked by wooden stakes or flagging. Once in place, the wetland boundary markers shall be maintained until a Certificate of Compliance has been issued by the Conservation Commission.

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C. General Conditions Under Massachusetts Wetlands Protection Act (cont.)

18. All sedimentation barriers shall be maintained in good repair until all disturbed areas have been fully stabilized with vegetation or other means. At no time shall sediments be deposited in a wetland or water body. During construction, the applicant or his/her designee shall inspect the erosion controls on a daily basis and shall remove accumulated sediments as needed. The applicant shall immediately control any erosion problems that occur at the site and shall also immediately notify the Conservation Commission, which reserves the right to require additional erosion and/or damage prevention controls it may deem necessary. Sedimentation barriers shall serve as the limit of work unless another limit of work line has been approved by this Order.

NOTICE OF STORMWATER CONTROL AND MAINTENANCE REQUIREMENTS

- 19. The work associated with this Order (the "Project") is (1) ⋈ is not (2) which subject to the Massachusetts Stormwater Standards. If the work is subject to the Stormwater Standards, then the project is subject to the following conditions:
 - a) All work, including site preparation, land disturbance, construction and redevelopment, shall be implemented in accordance with the construction period pollution prevention and erosion and sedimentation control plan and, if applicable, the Stormwater Pollution Prevention Plan required by the National Pollution Discharge Elimination System Construction General Permit as required by Stormwater Condition 8. Construction period erosion, sedimentation and pollution control measures and best management practices (BMPs) shall remain in place until the site is fully stabilized.
 - b) No stormwater runoff may be discharged to the post-construction stormwater BMPs unless and until a Registered Professional Engineer provides a Certification that: *i.* all construction period BMPs have been removed or will be removed by a date certain specified in the Certification. For any construction period BMPs intended to be converted to post construction operation for stormwater attenuation, recharge, and/or treatment, the conversion is allowed by the MassDEP Stormwater Handbook BMP specifications and that the BMP has been properly cleaned or prepared for post construction operation, including removal of all construction period sediment trapped in inlet and outlet control structures; *ii.* as-built final construction BMP plans are included, signed and stamped by a Registered Professional Engineer, certifying the site is fully stabilized;

iii. any illicit discharges to the stormwater management system have been removed, as per the requirements of Stormwater Standard 10;

iv. all post-construction stormwater BMPs are installed in accordance with the plans (including all planting plans) approved by the issuing authority, and have been inspected to ensure that they are not damaged and that they are in proper working condition;
 v. any vegetation associated with post-construction BMPs is suitably established to withstand erosion.



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C. General Conditions Under Massachusetts Wetlands Protection Act (cont.)

- c) The landowner is responsible for BMP maintenance until the issuing authority is notified that another party has legally assumed responsibility for BMP maintenance. Prior to requesting a Certificate of Compliance, or Partial Certificate of Compliance, the responsible party (defined in General Condition 18(e)) shall execute and submit to the issuing authority an Operation and Maintenance Compliance Statement ("O&M Statement) for the Stormwater BMPs identifying the party responsible for implementing the stormwater BMP Operation and Maintenance Plan ("O&M Plan") and certifying the following: i.) the O&M Plan is complete and will be implemented upon receipt of the Certificate of Compliance, and ii.) the future responsible parties shall be notified in writing of their ongoing legal responsibility to operate and maintain the stormwater management BMPs and implement the Stormwater Pollution Prevention Plan.
- d) Post-construction pollution prevention and source control shall be implemented in accordance with the long-term pollution prevention plan section of the approved Stormwater Report and, if applicable, the Stormwater Pollution Prevention Plan required by the National Pollution Discharge Elimination System Multi-Sector General Permit.
- e) Unless and until another party accepts responsibility, the landowner, or owner of any drainage easement, assumes responsibility for maintaining each BMP. To overcome this presumption, the landowner of the property must submit to the issuing authority a legally binding agreement of record, acceptable to the issuing authority, evidencing that another entity has accepted responsibility for maintaining the BMP, and that the proposed responsible party shall be treated as a permittee for purposes of implementing the requirements of Conditions 18(f) through 18(k) with respect to that BMP. Any failure of the proposed responsible party to implement the requirements of Conditions 18(f) through 18(k) with respect to that BMP shall be a violation of the Order of Conditions or Certificate of Compliance. In the case of stormwater BMPs that are serving more than one lot, the legally binding agreement shall also identify the lots that will be serviced by the stormwater BMPs. A plan and easement deed that grants the responsible party access to perform the required operation and maintenance must be submitted along with the legally binding agreement.
- f) The responsible party shall operate and maintain all stormwater BMPs in accordance with the design plans, the O&M Plan, and the requirements of the Massachusetts Stormwater Handbook.



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C. General Conditions Under Massachusetts Wetlands Protection Act (cont.)

- g) The responsible party shall:
 - Maintain an operation and maintenance log for the last three (3) consecutive calendar years of inspections, repairs, maintenance and/or replacement of the stormwater management system or any part thereof, and disposal (for disposal the log shall indicate the type of material and the disposal location);
 - 2. Make the maintenance log available to MassDEP and the Conservation Commission ("Commission") upon request; and
 - Allow members and agents of the MassDEP and the Commission to enter and
 inspect the site to evaluate and ensure that the responsible party is in compliance
 with the requirements for each BMP established in the O&M Plan approved by the
 issuing authority.
- h) All sediment or other contaminants removed from stormwater BMPs shall be disposed of in accordance with all applicable federal, state, and local laws and regulations.
- i) Illicit discharges to the stormwater management system as defined in 310 CMR 10.04 are prohibited.
- j) The stormwater management system approved in the Order of Conditions shall not be changed without the prior written approval of the issuing authority.
- k) Areas designated as qualifying pervious areas for the purpose of the Low Impact Site Design Credit (as defined in the MassDEP Stormwater Handbook, Volume 3, Chapter 1, Low Impact Development Site Design Credits) shall not be altered without the prior written approval of the issuing authority.
- I) Access for maintenance, repair, and/or replacement of BMPs shall not be withheld. Any fencing constructed around stormwater BMPs shall include access gates and shall be at least six inches above grade to allow for wildlife passage.

Special Conditions (if you need more space for additional conditions, please attach a text document):

CEE DAGE 40 OF THIS O	PRED OF COMPITIONS FOR FINDINGS OF FACT AND
SEE PAGE 13 OF THIS O	RDER OF CONDITIONS FOR FINDINGS OF FACT AND
SPECIAL CONDITION.	



WPA Form 5 – Order of Conditions

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D. Findings Under Municipal Wetlands Bylaw or Ordinance

١.	ls a	a municipal wetlands bylaw or ordinance applicable? Yes No				
2.	The	ne ACTON hereby finds (check one that app Conservation Commission	olies):			
	 a.					
		1. Municipal Ordinance or Bylaw 2. Citat	ion			
		Therefore, work on this project may not go forward unless and until a revised Not Intent is submitted which provides measures which are adequate to meet these standards, and a final Order of Conditions is issued.	tice of			
	b.	that the following additional conditions are necessary to comply with a munici ordinance or bylaw:	pal			
		1. Municipal Ordinance or Bylaw 2. Citat	ion			
The Commission orders that all work shall be performed in accordance with the follow conditions and with the Notice of Intent referenced above. To the extent that the follow conditions modify or differ from the plans, specifications, or other proposals submitted the Notice of Intent, the conditions shall control.						
	The special conditions relating to municipal ordinance or bylaw are as follows (if you need more space for additional conditions, attach a text document):					
	EXEMPT					



WPA Form 5 – Order of Conditions

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP: 85-1070

MassDEP File #

eDEP Transaction #

ACTON City/Town

A AL

E. Signatures

This Order is valid for three years, unless otherwise specified as a special condition pursuant to General Conditions #4, from the date of issuance.

Please indicate the number of members who will sign this form. This Order must be signed by a majority of the Conservation Commission.

1. Date of Issuance

Seven
2. Number of Signers

The Order must be mailed by certified mail (return receipt requested) or hand delivered to the applicant. A copy also must be mailed or hand delivered at the same time to the appropriate Department of Environmental Protection Regional Office, if not filing electronically, and the property owner, if different from applicant.

Signatures:	yames C. Why
Jerrence Mouttans	Themas B. awold
Fran Portanto	William Frohera
Chy of	Maye
☐ by hand delivery on	by certified mail, return receipt
•	requested, on $9/19/201$

Date

F. Appeals

Date

The applicant, the owner, any person aggrieved by this Order, any owner of land abutting the land subject to this Order, or any ten residents of the city or town in which such land is located, are hereby notified of their right to request the appropriate MassDEP Regional Office to issue a Superseding Order of Conditions. The request must be made by certified mail or hand delivery to the Department, with the appropriate filing fee and a completed Request of Departmental Action Fee Transmittal Form, as provided in 310 CMR 10.03(7) within ten business days from the date of issuance of this Order. A copy of the request shall at the same time be sent by certified mail or hand delivery to the Conservation Commission and to the applicant, if he/she is not the appellant.

Any appellants seeking to appeal the Department's Superseding Order associated with this appeal will be required to demonstrate prior participation in the review of this project. Previous participation in the permit proceeding means the submission of written information to the Conservation Commission prior to the close of the public hearing, requesting a Superseding Order, or providing written information to the Department prior to issuance of a Superseding Order.

The request shall state clearly and concisely the objections to the Order which is being appealed and how the Order does not contribute to the protection of the interests identified in the Massachusetts Wetlands Protection Act (M.G.L. c. 131, § 40), and is inconsistent with the wetlands regulations (310 CMR 10.00). To the extent that the Order is based on a municipal ordinance or bylaw, and not on the Massachusetts Wetlands Protection Act or regulations, the Department has no appellate jurisdiction.



WPA Form 5 – Order of Conditions

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP: 85-1070

MassDEP File #

eDEP Transaction #
ACTON
City/Town

G. Recording Information

Prior to commencement of work, this Order of Conditions must be recorded in the Registry of Deeds or the Land Court for the district in which the land is located, within the chain of title of the affected property. In the case of recorded land, the Final Order shall also be noted in the Registry's Grantor Index under the name of the owner of the land subject to the Order. In the case of registered land, this Order shall also be noted on the Land Court Certificate of Title of the owner of the land subject to the Order of Conditions. The recording information on this page shall be submitted to the Conservation Commission listed below.

ACTON Conservation Commission		
Detach on dotted line, have stamped by the Registr Commission.		to the Conservation
To:		
ACTON Conservation Commission		
Please be advised that the Order of Conditions for	the Project at:	
4-8 Central Street - South Acton Train Station Project Location	85-1070 MassDEP File Number	
Has been recorded at the Registry of Deeds of:		
Middlesex South County	Book	Page
for: Property Owner		
and has been noted in the chain of title of the affect	cted property in:	
Book	Page	
In accordance with the Order of Conditions issued	on:	
Date		
If recorded land, the instrument number identifying	this transaction is:	
Instrument Number		
If registered land, the document number identifying	g this transaction is:	
Document Number		
Signature of Applicant		

FINDINGS OF FACT

AND

SPECIAL CONDITIONS

REQUIRED BY THE ACTON CONSERVATION COMMISSION:

FINDINGS OF FACT:

- 1. The Commission finds that the wetland area located on the south side of the tracks, adjacent to the west end of the south-side platform is Bordering Vegetated Wetland (BVW) (approximate plan location 1337+00 to 1339+00).
- 2. The Commission finds that the wetland north of the track at approximate plan location 1335+00 is an isolated wetland that may be Isolated Land Subject to Flooding (ILSF) and does not have a buffer zone.

SPECIAL CONDITION:

A planting plan shall be prepared and submitted for Conservation Commission approval prior to construction. The plan shall consist of native shrub species, planted ten feet on center, and an uplands seed mix. The plan will include the buffer zone impacted by the construction of the south-side platform between approximate plan location 1337+/-30 and 1338+/-70.

WATER MAINS AND APPURTENANCES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Furnishing pipe for water main extensions.
- B. Furnishing miscellaneous appurtenances.
- C. Installation.
- D. Testing.

1.02 REFERENCE STANDARDS

- A. ANSI A21.4/AWWA C104 Cement Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings for Water.
- B. ANSI A21.10/AWWA C110 Gray Iron and Ductile Iron Fittings, 3" through 48", for Water and Other Liquids.
- C. ANSI A21.53-88/AWWA C153 Ductile iron compact fittings, 3" through 16", for water and other liquids.
- D. ANSI A21.11/AWWA C111 Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
- E. ANSI A21.51/AWWA C151 Ductile Iron Pipe.
- F. AWWA C600 Installation of Cast Iron Water Mains.
- G. AWWA C601 Disinfecting Water Main.
- H. AWWA C150 Thickness Design for Ductile Iron Pipe

1.03 SUBMITTALS

A. Submit shop drawings and product data in accordance with Division 1.

1.04 INSPECTION AND TESTING

- A. All pipe and fittings shall be inspected and tested at the foundry as required by the standard specifications to which the material is manufactured. The Contractor shall furnish in duplicate to the Engineer sworn certificates of such tests.
- B. Pipes and fittings shall be subjected to a careful inspection and a hammer test just before being laid or installed.

PART 2 PRODUCTS

2.01 GENERAL

- A. All products included in this section shall conform to the requirements of the standard specifications referenced herein.
- B. Pipe size shall be as shown on the Drawings.
- C. All pipe materials and methods of jointing shall be as shown on the Drawings.

2.02 PIPE AND FITTINGS

A. Ductile Iron Pipe: Pipe shall be designed in accordance with AWWA C150 and shall conform to ANSI A21.51/AWWA C151, Class 52 and shall have push-on joints. Pipe shall be double cement-lined with seal coat inside and out, conforming to ANSI A21.4/AWWA C104. Push-on joints and rubber gaskets shall be in accordance with ANSI A21.11/AWWA C111. Pipe shall be U.S. manufactured.

B. Pipe Fittings:

- 1. Fittings shall be compact ductile iron, 350 psi pressure rating, conforming to ANSI A21.53-88/AWWA C153 with mechanical joints. Joints and gaskets shall conform to ANSI 21.11/AWWA C111. Joints shall be furnished with ductile iron follower glands. Fittings shall be cement-lined and seal-coated inside and out or epoxy coated in accordance with ANSI A21.4/AWWA C104. Tees for hydrant branches and for stubs for future use shall have mechanical joints on the run with a plain end having an integral rotating gland on the branch. The gland will anchor mechanical joint pipe or valve ends to the plain end of the tee. Fittings shall be U.S. manufactured.
- C. All ductile and cast iron pipe and fittings shall be clean, sound and without defects. The castings shall be smooth and free from pinholes, excess iron, etc. The coatings shall be continuous, smooth and neither brittle nor sticky.
- D. The pipe manufacturer shall supply the Engineer with certificates of compliance with these specifications and certification that <u>each</u> piece of ductile iron pipe has been tested at the foundry with the Ball Impression Test, Ring Bending or other approved test for ductility.
- E. Joint restraining devices on all bends, tees, plugs and hydrants shall be Mega-Lug Series 1100 by EBAA Iron or approved equal. Restraining glands using set screws will not be accepted.

2.03 VALVES

A. Resilient Seated Gate Valves

- Buried gate valves shall be non-rising stem, iron-body, bronze-mounted, resilient seated with mechanical joint ends. Gate valves shall conform to AWWA C500. Gate valves shall be designed for a working pressure of 200 psi for sizes up to 12-inches in diameter. Valves shall be Waterous Series 500, American Flow Control Model AFC-2500, M & H, U.S. Pipe Metroseal or approved equal.
- Operating nuts shall be 2-inches square and shall open as specified. Stuffing box follower bolts shall be of plated steel and nuts shall be of bronze. O-ring stuffing boxes shall be used.
- 3. The design and machining of valves shall be such as to permit replacing O-rings on the valve without undue leakage while wide open and in service.
- 4. Valves shall be manufactured to meet or exceed the requirements to AWWA C-509 of *-A representative of the Water Supply District of Acton must inspect all installations prior to backfill 3/13/2012

latest revision. Valves shall have an unobstructed water way when fully opened equal in

5. All internal surfaces shall be coated with epoxy to a minimum thickness of 4 mils. Said coating shall be non-toxic, impart no taste to water and shall conform to AWWA C-550 of latest revision.

diameter to at least the nominal valve size. Valves shall have mechanical joint end.

- 6. Valves shall be provided with two O-ring stem seals. Both O-rings shall be located above the thrust collar. The sealing mechanism shall provide a dual seal with zero leakage at the water working pressure when installed with the line flow in either direction, and shall consist of a cast iron gate having a vulcanized synthetic rubber coating with no rubber metal seams or edges in the water way when in the fully closed position.
- All valves shall be seat tested at the rated working pressure in accordance with Section 6 of AWWA C-509. Valve shall be rated at 200 psi working pressure and 400 psi test pressure.
- 8. Valves shall open left.

B. Valve Boxes

- 1. Valve boxes shall be furnished for all valves and shall be made in North America. Shop drawings will be required for approval before delivery.
- 2. Valve boxes shall be standard cast-iron, asphalt coated, adjustable, sliding type, together with cast-iron covers with the word "water" plainly cast in relief on the top surface.
- 3. The bottom section shall have a minimum I.D. of 5-1/4-inches. The top section shall have a minimum diameter of 6-1/8-inches. There shall be a minimum 6-inch overlap between sections.
- 4. The bottom section shall be 48-inch in length for all butterfly valves and 36 inches in length for all gate valves. The top section shall be at least 26 inches in length and have a plain bottom. No three-piece combinations shall be acceptable.
- 5. Valve boxes shall be completely and thoroughly coated with bitumastic paint.

2.05 HYDRANTS

- A. Hydrants shall conform to the requirements of AWWA C-502, and be designed for 150 psi working pressure tested to 300 psi hydrostatic. Hydrants shall have 6-inch mechanical joint shoe, 5-1/4-inch valve opening, 5'-6" bury, <u>open left</u> with two 2-1/2-inch hose nozzles and one 4-1/2-inch pumper connection, National Standard Threads, operating nut and nozzle cap with non-kink safety chains.
- B. Hydrants shall be the compression type, closing with the pressure. They shall be traffic model with safety flange and stem couplings. All hydrants shall be Mueller Centurion, Darling B-62-B, or approved equal.
- C. Hydrants shall be able to be rotated 360 degrees. They shall have a positive closing, selfcleaning drain valve and drainage area shall be completely bronze or brass lined.
- D. Hydrants shall be painted with <u>one</u> coat of rust inhibitive primer and one coat of red with white caps to match District=s standard colors. The paint shall be an epoxy paint approved by the District.

2.06 MISCELLANEOUS

A. Polyethylene Tubing

Tubing for buried water services and chlorine injection points shall be polyethylene American made designed for 200 psi minimum service. Tubing shall conform to AWWA C-901 latest revisions. The tubing shall be copper O.D. size and be suitable for use with standard industry brass compression fittings without special adapters. Insert stiffeners shall provided for use with all compression joint connections. Tubing shall be Drisco Pipe, Hydro-Flo or approved equal.

B. Corporation Stops

Corporation stops shall be of brass, Series 110 manufactured by Mueller, or approved equal. The inlet shall have Mueller threads and the outlet shall have compression connection.

C. Curb Stops and Boxes

- Curb stops shall be of brass composition with drain, and shall be Mueller, Mark II Oriseal or approved equal. The inlet shall have Mueller threads and the outlet shall have compression connections.
- 2. Each curb stop shall be provided with a cast iron box. The valve box shall be a two-hole cover Erie Box with rod.
- 3. The cast iron box shall be the extension type with arch pattern. Inside diameter of upper section shall be at least 2-1/2" for 3/4" and 1" curb stops and shall be at least 3" for 1-1/2" and 2" curb stops. The bottom section 100E shall be slide type 54" long.

D. Couplings

1. Couplings to be used in connecting two plain ends of cast, ductile iron, or asbestos cement pipe shall be the stab type with compression ends. Center sleeves shall be carbon steel tubing conforming to ANSI/AWWA C200. Gaskets shall be multi-range two layered EPDM gaskets, NSF-61 approved. One or two type 304 stainless steel bolts and nuts conforming to AWWA C219-01 shall be provided with each coupling, depending on the size. The interior and exterior surfaces shall be coated with an NSF-61 approved fusion bonded epoxy coating. The coupling shall provide a minimum deflection of 8 degrees, and up to a working pressure of 260 psi with zero leakage. Couplings shall be Hymax models 2000/2100 as manufactured by Total Piping Solutions.

E. Detectable Tracer Tape

Tracer tape shall be a minimum of 3 inches wide. The upper face of the tape shall be of a
highly visible color easily detectable when exposed by digging. The upper face shall carry
the warning of the buried water main below. The tape shall have a metallic backing in
order that it may be traced by metal or pipe locators. It shall be used over all non-metallic
pipe.

PART 3 EXECUTION

3.01 GENERAL

A. Pipe and accessories shall be handled and stored in such a manner as to insure that pipe is installed in sound, undamaged condition. Particular care shall be taken not to injure the pipe coating or lining. B. Ductile iron pipe and fittings and the cement linings are comparatively brittle. Every care shall be taken in handling and laying pipe and fittings to avoid damaging the pipe or lining, scratching or marring machined surfaces, and abrasion of the pipe coating or lining.

- C. Any pipe showing a distinct crack with no evidence of incipient fracture beyond the limits of the visible crack, if approved, may have the cracked portion cut off by, and at the expense of, the Contractor before the pipe is laid so that the pipe used is perfectly sound. The cut shall be made in the sound barrel at a point at least 12 inches from the visible limits of the crack.
- D. If authorized, cutting of the pipe shall be done so that the cut is square and clean, without causing damage to the pipe lining. Unless otherwise authorized by the Engineer, all pipe cutting shall be done by means of an approved type of power cutter. The use of hammer and chisel, or any other method which results in rough edges, chips and damaged pipe, is prohibited. All cut edges shall be field beveled by use of a power grinder, as required, prior to installation.
- E. Each pipe section shall be placed into position in the trench in such manner and by such means required to cause no damage to the pipe, person or to property.
- F. The Contractor shall furnish slings, straps and/or approved devices to provide satisfactory support of the pipe when it is lifted. Transportation from delivery areas to the trench shall be restricted to operations which can cause no damage to the pipe units.
- G. Pipe shall not be dropped from trucks onto the ground or into the trench.
- H. The Contractor shall have on the job site, with each laying crew, all the proper tools to handle and cut the pipe.
- I. Damaged pipe coating and/or lining shall be restored before installation only as approved or directed by the Engineer.

3.02 CONTROL OF ALIGNMENT AND GRADE

- A. The Engineer has shown easement and property and other control lines necessary for locating the work as well as elevations and benchmarks used in the design of the work on the Drawings.
- B. The contractor shall use this information to set line and use a surveyor's level or transit to set grade as required.
- C. The use of string levels, hand levels, carpenter's levels or other curved devices for transferring grade or setting pipe are not permitted.
- D. During construction, the Contractor shall provide the Engineer, at his request, all reasonable and necessary materials, opportunities, and assistance for setting stakes and making measurements, including the furnishing of one or two rodmen or chain men as needed at intermittent times. He shall not proceed until he has made timely request of the Engineer for, and has received from him, such controls and instructions as may be necessary for the work to progress. The work shall then be done in strict conformity with such controls and instructions.

The Contractor shall carefully preserve benchmarks, reference points and stakes, and in case of willful or careless destruction by his own men, he will be charged with the resulting expense and shall be responsible for any mistakes or delay that may be caused by their unnecessary loss or disturbance.

3.03 PREPARATION OF BED

- A. As soon as excavation has been completed to required depth, place and compact bedding material to the elevation necessary to bring the pipe to grade as specified in Section 02220.
- B. The compacted bed shall be rounded so that at least the bottom quadrant of the pipe shall rest *-A representative of the Water Supply District of Acton must inspect all installations prior to backfill 3/13/2012

firmly for the full length of the barrel. Suitable holes for bells or couplings shall be dug around the pipe joints to provide ample space for making tight joints.

- C. The trench bottom shall be straight, free of bumps or hollows and at the proper depth. Any irregularities in the trench bottom shall be leveled off or filled in with a selected gravel or sand thoroughly tamped.
- D. If determined by the Engineer, the trench bottom shall be prepared by digging at least 6-inch deeper than pipe grade and backfilling to proper grade with a selected gravel or sand backfill properly tamped.
- E. All unsuitable material shall be removed from the bottom of the trench excavation as directed by the Engineer to the depths ordered. The trench shall be backfilled with an approved gravel backfill material, placed in 6-inch layers, to within 6-inches of proper pipe grade. Each gravel lift shall be thoroughly tamped. A 6-inch layer of selected gravel or sand shall be placed and tamped for proper pipe support.

3.04 LAYING PIPE

- A. Laying of pipe and fittings shall be in accordance with the requirements of AWWA Standard Specifications for Installation of Cast-Iron Water Mains, C600, except as otherwise provided herein.
- B. Each pipe length shall be inspected for cracks, defects in coating or lining, and any other evidences of unsuitability. Contractor shall excavate a minimum amount of trench and shall backfill trench to within 2 lengths of pipe laying. All trenches shall be backfilled at night.
- C. Pipe shall be laid in the dry and at no time shall water in the trench be permitted to flow into the pipe.
- D. The pipe shall then be laid on the trench bedding, and the pipe pushed home. Jointing shall be in accordance with the manufacturer's instructions and appropriate ASTM Standards, and the Contractor shall have on hand for each pipe laying crew, the necessary tools, gauges, pipe cutters, etc. necessary to install the pipe in a workmanlike manner. Pipe laying shall proceed upgrade with spigot ends pointing in the direction of flow.
- E. Blocking under the pipe will not be permitted except where a concrete cradle is proposed, in which case precast concrete blocks shall be used.
- F. If inspection of the pipe indicates that the pipe has been properly installed as determined by the Engineer, the Contractor may then refill or backfill the remainder of the trench in accordance with the specifications.
- G. At any time that work is not in progress, the end of the pipe shall have a temporary plug to prevent the entry of animals, earth, water, etc.
- H. Acceptable alignment shall be preserved in laying. The deflection at joints shall not exceed 3 degrees, or 12 inches for an 18-foot length of pipe. Fittings, in addition to those shown on the Drawings, shall be provided, if required, in crossing utilities which maybe encountered upon opening the trench. Solid sleeves shall be used only where approved by the Engineer.
- I. Concrete thrust blocks shall be installed at all fittings and other locations as directed by the Engineer. Minimum bearing area shall be as shown on the Drawings. Joints must be protected by felt roofing paper prior to placing concrete. Concrete shall be placed against undisturbed material, and shall not cover joints, bolts or nuts, or interfere with the removal of any joint. Wooden side forms shall be provided for thrust blocks.
- J. Push-on joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends on the upstream side. A rubber gasket shall be inserted in the groove *-A representative of the Water Supply District of Acton must inspect all installations prior to backfill 3/13/2012

of the bell end of the pipe and joint surfaces cleaned and lubricated. The plain end of the pipe to be entered shall then be inserted in alignment with the bell of the pipe to which it is to be jointed and pushed home with a jack or by other means. After jointing the pipe, a metal feeler shall be used to make certain that the rubber gasket is located correctly.

K. Mechanical joints at valves, fittings and where designated shall be in accordance with the "Notes on Method of Installation" under ANSI Specification A21.11 and the instruction of the manufacturer. To assemble the joints in the field, the Contractor shall thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tight to the specified torques. Under no conditions shall extension wrenches or pipe over handle or ordinary ratchet wrench be used to secure greater leverage.

3.05 INSTALLATION OF VALVES AND FITTINGS

- A. Valves and boxes shall be set with the stem vertical and box vertically centered over operating nut. Valves shall be set on a firm foundation and supported by tamping selected excavated material under and at the sides of the valve. The gate box shall be supported during backfilling and maintained in vertical alignment with the top flush with finish grade.
- B. Valves shall be anchored to all tees or fittings with 3/4" threaded rods, wherever possible or as directed by the Engineer.
- C. Install couplings and fittings in accordance with manufacturer's instructions.

3.06 INSTALLATION OF HYDRANTS

A. Hydrants shall be set at the location shown and bedded on a firm foundation. A drainage pit 3 feet in diameter and 2 feet deep below and to the rear of the hydrant shall be filled with crushed stone and satisfactorily compacted. During backfilling, additional peastone shall be brought up around and 6 inches over the drain port. Where directed by the Engineer, the Contractor shall install plugs in the hydrant drain ports. No hydrant shall be backfilled until Contractor is directed to do so by the Engineer. Each hydrant shall be set in true vertical alignment and properly braced. Concrete thrust blocks shall be placed between the back of the hydrant inlet and undisturbed soil at the end of the trench. All hydrants shall be rodded to the gate valves using 3/4-inch threaded rod and duclugs. Minimum bearing area shall be as shown on the Drawings. Roofing felt shall be placed around hydrant elbow before placing concrete. Care shall be taken to insure that concrete does not plug the drain ports.

3.07 INSTALLATION OF CORPORATION AND SERVICES

- A. The tapping machine shall be rigidly fastened to the pipe half way between the horizontal and vertical position. The length of travel of the tap should be so established that when the stop is inserted and tightened with a 14 inch wrench, not more than one to three threads will be exposed on the outside. When a wet tapping machine is used, the corporation stop shall be inserted with the machine while it is still in place. Stops shall be tightened only sufficiently to give water tightness, and care must be constantly exercised not to overtighten them. Service saddles must be installed for all taps into PVC pipe.
- B. Care shall be exercised in the placing and laying of tubing to be sure that the pipe does not have kinks or sharp stones or ledge which would cause damage to the pipe. Place at least 6 inches of sand as shown on the Drawings, adjacent to, above and below the tubing. No stone shall be dropped on the tubing until the depth of backfill above the tubing is in excess of one foot.
- C. Make connections of new services with existing services unless otherwise directed by the Engineer. Use bushings and/or couplings as required to connect new tubing with existing services.

3.08 INSTALLATION OF MANUAL AIR RELEASE/CHLORINATION INJECTION POINTS

A. Install each gate box vertically, centered over the operating key, with the elevation of the top adjusted to conform to the finished surface at the completion of the Contract. Adequately support the box during backfilling to maintain vertical alignment.

- B. Installation of 1-inch air vents and chlorination taps shall be in accordance with paragraph 3.07 Installation of Services. Service Saddles must be used.
- C. The exact location of the manual air releases will be determined in the field.

3.09 TESTING

- A. The Contractor shall furnish all labor, pumps, taps, chemicals, and other necessary equipment to conduct hydrostatic pressure tests and measured leakage test; and to disinfect thoroughly the mains laid under this contract in accordance with Section 4 AWWA C600-82 Installation of Ductile Iron Water Main.
- B. The tests and disinfection shall be conducted at a time specified by and under the supervision and direction of the Engineer who shall judge the success or failure of the work to meet the required standards.
- C. In the event that the work fails to meet the required standards as stated herein, the Contractor shall perform such excavation, repair, relaying of pipe, rechlorinating, and all other work necessary to correct the work; and shall repeat the tests or chlorination as often as may be necessary and until such time as the required standards are met.

3.10 PRESSURE TESTS

- A. Before applying the specified test pressure, all air shall be expelled from the pipe. If suitable means of expelling air are not available at high places, the Contractor shall make all the necessary taps as shown on plans or as the Engineer may direct. After the tests have been completed, the corporation stops shall be left in place or removed and plugs inserted, as directed by the Engineer or Owner.
- B. The newly laid pipe shall be tested in valved or plugged sections as determined by the Engineer in the field. Water shall be slowly introduced into the section being tested by means of an approved power-driven high pressure test pump.
- C. The new laid pipeline shall be tested to a pressure equal to 150% of the maximum static pressure for the section being tested, measured at the lowest point of the section being tested corrected to the elevation of the test gauge. If the static pressure of any newly laid section of pipeline being tested is less than 100 psig measured at the lowest point of the pipeline section, then the minimum test pressure shall be 150 psig.
- D. The pressure shall be raised to the test pressure required for each section being tested as determined by the Engineer. When the test pressure is reached, the time shall be recorded and the test shall begin. The duration of each pressure test shall be a minimum of two hours. During the test, pressure shall be maintained in the section of pipeline being tested by means of a recirculating by-pass type test pump. Water shall be added in measured amounts from a container of known volume if required to maintain pressure. The addition of excessive amounts of water shall constitute immediate test failure. The Engineer will approve all gauges and test equipment.
- E. During the test, the line will be examined by the Engineer for visible leaks and breaks. Any defects in the works shall be repaired, and any defective materials shall be removed and replaced by the Contractor as and where directed by the Engineer.

3.11 LEAKAGE TEST

A. <u>Method of Testing.</u> The leakage test shall be conducted concurrently with the pressure test.

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Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain pressure within 5 psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

B. No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = \frac{SD/P}{133,200}$$

in which L is the allowable leakage, in gallons per hour; S is the length of pipe tested, in feet; D is the nominal diameter of the pipe, in inches; and P is the average test pressure during the leakage test, in pounds per square inch gauge.

C. Allowable leakage at various pressures is shown in the following table.

Allowable Leakage per 1000 ft (305 m) of Pipeline*--gph**

Allowable Leakage per 1000 ft (303 ftf) of Pipeliftegpfi													
	N	Nominal Pipe Diameter-in.											
Avg. Test Pressure psi (Bar)	3	4	6	8	10	12	14	16	18	20	24	30	36
450 (31)	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73
400 (28)	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41
350 (24)	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06
300 (21)	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68
275 (19)	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48
250 (17)	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27
225 (16)	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05
200 (14)	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82
175 (12)	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58
150 (10)	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31
125 (9)	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02
100 (7)	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70

^{*}If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

- D. When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gal/h/in. of nominal valve size shall be allowed.
- E. When hydrants are in the test section, the test shall be made against the closed hydrant.
- F. Acceptance shall be determined on the basis of allowable leakage. If any test of pipe laid discloses leakage greater than that specified, the Contractor shall, at his own expense, locate and make repairs as necessary until the leakage is within the specified allowance.
- G. All visible leaks are to be repaired regardless of the amount of leakage. At the end of the test period if

^{**}To obtain leakage in liters/hour, multiply the values in the table by 3.785.

^{*-}A representative of the Water Supply District of Acton must inspect all installations prior to backfill

the amount of water added to the main from the calibrated vessel is less than the allowable leakage, and if the line shows no visible leaks or other failures, that portion of the main tested will be approved by the Engineer.

3.12 TESTING OF VALVES AND HYDRANTS

- A. All valves and hydrants shall be pressure tested during the main pipeline test. Hydrant gate valves shall remain open during the main pressure test. After the pipeline has been pressure tested and accepted the hydrant gate valve shall be closed and the hydrant valve cracked open to release some pressure on the hydrant side of the gate valve. An acceptable test for each hydrant gate valve shall be no loss of pressure in the main line test pressure as each valve is closed.
- B. All main line butterfly or gate valves and control valves on any intersecting side streets shall also be tested by the same procedures outlined above as far as practical. The Engineer shall decide if it is impractical to test any one particular valve location. No pressure test shall be considered acceptable until all possible control valves have been tested to insure proper closing and water tightness.
- C. The Contractor shall make any taps and furnish all necessary caps, plugs, etc., as required in conjunction with testing. He shall also furnish a test pump, gauges and any other equipment required in conjunction with carrying on the hydrostatic tests. He shall at all times protect the new water mains and the existing water mains against the entrance of polluting material.

3.13 DISINFECTION

- A. After satisfactory pressure and leakage tests have been made, before placing the newly-laid mains in service, and when directed by the Engineer, the Contractor shall disinfect by chlorination.
- B. Prior to chlorination, the mains shall be flushed to remove dirt and other foreign substances.
- C. The mains shall be disinfected by the Contractor under the presence of the Engineer. Disinfection shall be in accordance with AWWA Standard C651.
- D. Following acceptance of the disinfection process, the chlorinated water shall be flushed from the newly-laid main until such time as the replacement water throughout its entire length shall be equal in quality to that elsewhere in the system. All chlorinated water shall be dechlorinated while it is being flushed from the main. The Contractor shall monitor the chlorine residual to insure effective dechlorination.
- E. Representative water samples shall be collected of the potable water in the new pipeline by the Contractor under the observation of the Engineer. These samples shall be taken to a Massachusetts DEP certified laboratory for a bacteria analysis. The pipeline will be considered acceptable when two consecutive negative Coliform samples have been obtained. The cost associated with the collection and analysis of the samples shall be paid for by the Contractor.
- F. Special disinfection procedures, such as soaking or swabbing, approved by the Engineer, shall be used in connections to existing mains and where the method outlined above is not practicable.

3.14 CONNECTION TO EXISTING SYSTEM

- A. The Contractor shall furnish all necessary labor, tools, joint materials, equipment, etc. to connect new water pipes to existing water pipes with the required proper fittings. Flexible transition couplings used to connect new water pipes to existing water pipes shall be as specified.
- B. All connections shall be made at such time and in such a manner as to cause as little interruption in water service as possible.

C. Coordination of all such work shall be made with the Engineer and owner who shall be present when the work is done and shall operate all valves. The Contractor shall notify the Engineer 24 hours in advance of when he plans to connect into the existing water mains.

D. All materials, equipment and labor necessary for the connection of the new water mains to the existing water mains shall be accomplished as shown on the plans or as directed by the Engineer and shall be considered subsidiary to the pipe laying items.

3.15 SEWER SERVICES, DRAIN LINES AND GAS MAINS

- A. The Contractor shall exercise caution to properly protect the existing sewer services and drain pipes from construction damage. It shall be the Contractor's responsibility to demonstrate that all existing active sewer services and drains are functioning properly after the installation of the proposed water main to the satisfaction of the Engineer.
- B. Damage to existing drains and sewer services shall be repaired and/or replaced with materials of the same size as the existing service. Existing slopes and inverts shall be maintained. Pipe joints shall be made using suitable flexible couplings, approved by the Engineer. Fernco couplings are an acceptable coupling for sewer service repair. The Contractor shall use same. Concrete mortar joints will not be accepted.
- C. If damage occurs to existing house or business sewer services or storm drains and acceptable repairs are accomplished as outlined above, the contractor shall be required to adequately demonstrate to the Engineer that the repaired service is functioning normally before any backfill material shall be allowed to be placed.
- D. The Contractor shall take extra precautions to properly protect the existing gas mains when installing new water mains. He shall become thoroughly familiar with the latest change to 220 C.M.R. Section 113.00, Operation, Maintenance, Replacement and Abandonment of Cast Iron Pipelines used for gas distribution with particular attention to subsections 113.06 and 113.07. The Contractor shall be required to properly support, backfill and compact all existing gas main crossings in accordance with paragraph 113.06. Proper backfilling and compaction shall be accomplished up to the top of all exposed gas main immediately after each piece of new water pipe is installed to the satisfaction of the Engineer.

END OF SECTION

Water Supply District of Acton

693 MASSACHUSETTS AVENUE P.O. BOX 953 ACTON, MASSACHUSETTS 01720-0953

TELEPHONE (978) 263-9107

FAX (978) 264-0148

Date:			
Account#:			
I would like to	apply for water service at the f	following address:	
For the follow	ing purpose only:	Will this service be 200 feet from t	he main?
	the following amount in accordance, or that may hereafter be made	ance with the "Rules, Regulations and Rates" set ford de.	h by the Water Supply
Pipe Size	Demand Charge	Fire Sprinkler Demand Charges	
Hydrant Flow to our office w Location of Flow Please fill in in	v Test - \$700.00 (two checks for vithin 90 days, \$350.000 will be ow Test: nformation below for new ser	· 	
Address:	·	Telephone #.	
Contact Person	·	Telephone #:	
Billing Addres	SS:	· · · · · · · · · · · · · · · · · · ·	
Has road open	ing permit been obtained?	Plans submitted with house number?	
Fire protection	n sprinkler required?	Will this property have an irrigation system	m?
Signature of ap	pplicant:		

APPLICATION IS VOID IF METER IS NOT INSTALLED WITHIN 18 MONTHS OF APPLICATION DATE

Please note: A final water meter reading must be done prior to closing on this property

APPENDIX E

ACTON WATER DISTRICT SPECIFICATIONS AND APPLICATION FOR SERVICE

APPENDIX F

MBTA RAILROAD OPERATIONS BOOK OF STANDARD PLANS – TRACK AND ROADWAY

MBTA RAILROAD OPERATIONS COMMUTER RAIL DESIGN STANDARDS MANUAL

APPENDIX F

MBTA RAILROAD OPERATIONS BOOK OF STANDARD PLANS – TRACK AND ROADWAY

MBTA RAILROAD OPERATIONS COMMUTER RAIL DESIGN STANDARDS MANUAL

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RAILROAD OPERATIONS

COMMUTER RAIL DESIGN STANDARDS MANUAL

VOLUME I SECTION I

TRACK AND ROADWAY

Revision No. 1 April 19, 1996

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CHAPTER 1
INTRODUCTION

A. Background

The Commuter Rail Design Standards are a two-volume series that establish design objectives, guidelines, and criteria for commuter rail track and roadway, communications systems, signal systems and stations. Originally developed in 1976 as part of the Commuter Rail Improvement Program, this two-volume series expanded the Massachusetts Bay Transportation Authority's earlier series of design standards manuals for the rapid transit system—the Manual of Guidelines and Standards—to the area of commuter rail. This document contains extensive revisions and additions to the 1976 edition.

B. Purpose of the Manual

The purpose of this Manual is to provide guidance to the Authority and it's design consultants in commuter rail design and construction work. Due to the constant evolution of products and accumulation of practical experience it is neither practical or necessary to rigidly "standardize" all elements of the commuter rail system. The approach of this Manual is to recommend standardization of design criteria, but of components and material only when it is economically justified or is required for legal or technical reasons.

While the need for total system standardization is not a practical priority, it <u>is</u> a priority that future improvements satisfy all safety requirements and regulations regardless of methods or material used. The designer should also aim to achieve economy of design based on the past accumulation of prior experience with commuter rail improvements as well as consistency with the character and quality of the system's design.

This Manual is an important tool toward achieving the general goals of safety, economy, and consistency. In general, these standards establish three levels of guidance in the design of system improvements—design objectives, design guidelines, and design criteria and details. The design objectives are a very general form of guidance, broadly outlining the desired results of a component or facility.

Design guidelines are a more specific form of guidance. They describe the level of performance a facility should achieve; in general terms, where it should be located; what types of user or other needs it should satisfy; standard dimensions and clearances to be achieved; and where appropriate, several approaches to meeting the guidelines. In short, guidelines represent a planning and programming level of guidance.

The most detailed guidance provided in the Manual is categorized as design criteria and details. These criteria and details may describe specific construction methods or materials which the Authority requires the designer to use in specific circumstances. An example is the use of full depth rubber rubber crossing panels at most grade crossings. More often, however, the criteria describe specific materials or methods of construction simply because they have been successfully used in previous commuter rail facilities and are likely to be applicable and successful on future projects.

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Within Section I of the Manual, Design Objectives and Guidelines are contained in one separate chapter. In Section II, Design Objectives and Guidelines are addressed in each chapter.

C. Organization of the Manual

The revised Manual is organized into two loose leaf volumes:

Volume 1. Section I - Track and Roadway. Section II - Stations and Parking Volume 2. Signal & Communications

The two volume Manual is organized in a loose-leaf format for the reasons of flexibility and convenience. The passage of time and experience will require continuous modifications of the design guidelines and criteria presented in the Manual. The loose-leaf format provides the flexibility needed to insert new pages and delete outdated material. In addition, the format simplifies the process of copying pages or sections of the Manual as needed to guide future design work.

D. Revisions

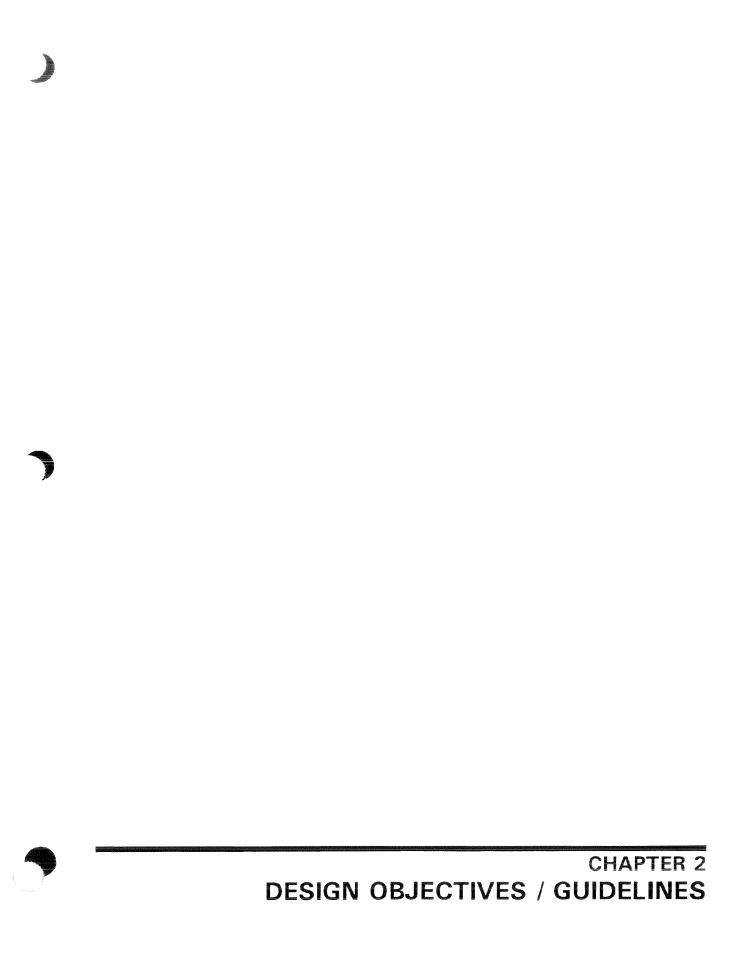
The revision number and date of issue are noted in the revision box. When revisions are made, the entire chapter and a new table of contents is issued. By consulting the current table of contents, it is possible to determine if the chapters in the Manual are the latest revision. Any designer working on projects for Railroad Operations should check with the Authority to confirm that they are using the most recent revision before proceeding.

E. Other Applicable Documents

In addition to the Design Standards Manual, there are three other documents which supplement the Track and Roadway, Section I of the Manual. The first two are essential for designers to have and use with this document.

- Book of Standard Plans Track and Roadway
- Railroad Operations Commuter Rail Material Specifications
- MW-1 Manual Maintenance of Way Manual

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A. Design Objectives

The objective of the Design Standards Manual for Track and Roadway shall be to provide a safe, efficient, and reliable fixed plant for the operation of the Massachusetts Bay Transportation Authority (MBTA) commuter rail services as well as through and local freight service over MBTA rights-of-way.

The use of these design standards is required for new installations or when general renewal or replacement of track and roadway materials is to be undertaken. Requirements for maintenance of existing track and roadway elements are contained in the Authority's separate MW-1 (Maintenance-of-Way) Manual. The separate Book of Standard Plans - Track and Roadway shall be considered as an extension of this section of the manual and plans contained therein are cited in this document as appropriate. Material Specifications for track and roadway material are contained in the document titled Railroad Operations - Commuter Rail Material Specifications which are also cited in this document as appropriate.

Track and roadway design and installation practices not specifically addressed in this Manual shall be in accordance with the current American Railway Engineering Association (AREA) Manual of Recommended Practice and Portfolio of Trackwork Plans.

All designers/consultants preparing plans and specifications for any project for MBTA Railroad Operation's facilities shall be required to use this document and the separate <u>Book of Standard Plans</u> as a basis for design. Exceptions are the Northeast Corridor between Boston and the Rhode Island state line where the requirements of Amtrak will be followed and any work on the Worcester Line west of Framingham Station where the requirements of Conrail will be followed.

It is recognized that field conditions and special situations often occur and present circumstances that cannot be addressed in the Manual. In these instances, it is the designer's responsibility to bring this to the attention of the Authority and direction will be given by the Chief Engineering Officer, Railroad Operations for that specific instance. In all cases, issues of safety shall be the primary concern.

B. Design Guidelines

The MBTA commuter rail system extends over portions of three former Class I railroads. Each had its own standards for track and roadway materials, designs, and practices. Since acquiring these properties in the 1970's, changes and improvements have eliminated many of the differences but some still exist.

For all new installations of track and roadway and major rehabilitation projects, the design standards specified herein and related documents noted in Chapter 1, Part E, shall apply in the interest of uniformity of design and maintenance.

Massachusetts Bay Transportation		Commuter Rail	Track and Roadway	Section
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Track and roadway components which are renewed shall adhere to current MBTA Standard Plans and Material Specifications.

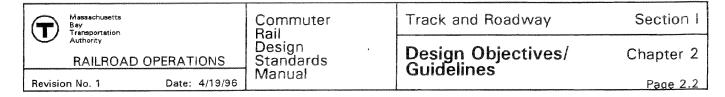
The following specific design guidelines and policies are basic to all track and roadway engineering design:

- 1. Safety The primary purpose of all engineering design shall be to provide for the safe operation of trains and elimination of hazards to personnel and equipment. Application of standard design to all situations is rarely possible. The designer is responsible to recognize when deviation from standards will be necessary and call it to the attention of Railroad Operations. The designer and Railroad Operations will work together to arrive at a satisfactory solution with safety the primary concern.
- 2. Reliability The design and choice of component materials shall be in accordance with MBTA Railroad Operations Standards, deviating only when specifically allowed by the Chief Engineering Officer, Railroad Operations.
- 3. Design Speed Maximum design speed for commuter rail shall be 70 mph and 100 mph where directed. However, the design for 70 MPH should not preclude a future increase to 79 mph¹. The present exception is the Northeast Corridor/Shore Line Main Line which will be up to 150 mph. Existing permanent operating speed restrictions shall be maintained unless a change is sanctioned by the Authority. Station areas are to be designed for maximum authorized speed of track in abutting territory to facilitate operation of express trains.
- 4. Clearances Minimum horizontal and vertical clearances shall conform to those shown on Standard Plans 1012 to 1019. In general, new design shall provide 14'-0" track centers and 8'-6" side clearance with appropriate compensation for curvature. In no case shall new design provide less than 13'-0" track centers. Vertical clearances will be on a site specific basis. (See Chapter 6)

For continuous adjacent structures greater than 100 feet in length, measured along the track base line and closer than 8'-6" to centerline of track, safety niches shall be provided. Such restricted clearance will require a variance from the Department of Public Utilities (DPU). Chapter 6 contains additional information on clearances.

- 5. Load Capacity Track and roadway shall be designed to accommodate heavy freight train traffic. Track bridges and other structures shall be designed for Cooper E-80 loadings as prescribed in the AREA Manual.
- 6. Grade Separation and Grade Crossings In general, new grade separation structures shall be provided wherever possible to eliminate crossings at grade. Existing and future public and private grade crossings shall

 $^{^{1}}$ 79 MPH is the maximum speed allowed by Federal Railroad Administration (FRA) without cab signals.



be protected with flashers and gates approved by the Massachusetts Department of Public Utilities. Private crossings used less than two crossings of track(s) per week may instead use crossbucks and a locked right-of-way gate. Key for gate to be given to property owner and an agreement signed by owner that gate shall be kept locked except when they are in actual use of crossing.

7. New Grade Crossings - No new public grade crossings, auto or pedestrian, of main tracks shall be permitted without the permission of the Director of Railroad Operations, the local community, the County Commissioners and approval of the warning system by the Massachusetts Department of Public Utilities.

No new private grade crossings shall be permitted without the expressed consent of the Director of Railroad Operations and subject to an agreement signed by the General Manager of the MBTA.

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A. Horizontal and Vertical Survey Control Requirements

Unless otherwise directed by the Chief Engineering Officer, Railroad Operations, the horizontal control used to establish rectangular coordinates for track geometry shall be based on the Massachusetts Plane Coordinate System, Mainland Zone. Horizontal control points and supporting survey shall meet U.S. Coast and Geodetic Survey second order specifications for accuracy with Class I requirements (1 part in 50,000) for projects encompassing more than 5 miles. Class II requirements (1 part in 20,000) will be adequate for projects less than 5 miles in length.

Vertical control shall be based on U.S. Coast and Geodetic Survey Mean Sea Level Datum, 1929 General Assessment. All vertical control points or benchmarks shall meet U.S. Coast and Geodetic Survey Second order Class II Specifications for accuracy. On small projects (less than 1 mile in length), third order requirements may be used.

B. Design Speeds

Design Speed	****	70* mph (100 mph where directed)
		(Do not preclude future increase to 79 mph)

Minimum Design Speed	– M	aximum	speed	allowed	bу	local
	С	onditio	ns			

Station Pass-By Speed	-	Maximum	authorized	speed	for
• •		territory	y ²		

Terminals, Terminal	- 2	0 mph	desirable
Approach Tracks and	- 1	5 mph	absolute minimum
Servicing Areas ³			

C. Track Geometrics

1. General

The horizontal alignment of tracks shall consist of a series of tangents connected with circular and compound curves with appropriate spirals. Vertical alignment shall consist of tangent grades connected by parabolic vertical curves as required by these criteria.

 $^{^3}$ Terminal areas include: Major stub end terminals, servicing areas, train storage yards and immediate approaches thereto.

Bay	ssachusetts / rsportation	Commuter Rail	Track and Roadway	Section
	AILROAD OPERATIONS	Design Standards	Geometric Design Criteria	Chapter 3
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 $^{^{1}}$ On certain routes, such as Northeast Corridor and others where station spacing, geometry, etc. permit - design for up to 150 mph as directed.

 $^{^{2}}$ Up to 2-3/4" unbalanced elevation permitted in stations to achieve maximum speed so as to minimize actual elevation in station.

2. Tangent Lengths - Horizontal

a. Mainline

Minimum desirable tangent lengths between reverse curves and/or spirals shall be 100 feet. In very limited areas where design speeds are 50 mph or less, tangents of lessor distance may be permitted with permission of Chief Engineering Officer, Commuter Rail and if spirals are long enough to provide less than a one half inch change in reverse cross level over 62 feet. Short tangents between curves in same direction (broken back curves) should be avoided by compounding to a flatter curve or using a connecting spiral.

b. Yards

In terminals and yard areas where design speed is 20 mph or less, tangent length may be reduced to 65 feet (the approximate truck spacing of an 85' long car) and, within yards only, when space is very limited and with permission of Chief Engineering Officer, the following table may be used:

Degree of	Minimum Recommended
<u>Reverse Curves</u>	<u>Tangent Length (Feet)</u>
Less than 7° - 8° 8° - 9° 9° - 10° 10° - 11° 11° - 12° 12° - 13°*	20 25 30 40 50 60

^{*}Curves this sharp normally not permitted.

TABLE 3.1

C. Turnouts and Crossovers

The use of "back to back" turnouts of the same hand which results in a reverse curve, is prohibited unless a tangent length of at least 65 feet measured from PS to PS of the turnouts is added. Maintaining this dimension is especially critical with No. 8 & 10 turnouts. In yards and other low speed areas, the criteria indicated in Table 3.1 above may be used with permission. A No. 10 turnout has an equivalent radius of about 8° and a No. 8 about 12°-30'. It should be noted that a No. 8 crossover in track centers less than 14'=0" will not meet the criteria in the above table. No. 8 crossovers should therefor be avoided and used only with permission of the Chief Engineering Officer where absolutely necessary.

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Curve Length

The minimum curve length (not counting connecting spirals) shall be 100 feet. In compound curves, each curve segment of differing radius should be at least 100 feet long.

4. Horizontal Geometry

a. Curve Definition

Curves shall be defined by chord definition and specified by degree. Arc definition shall not be used.

$$R = \frac{50}{\sin D/2} \quad \text{or} \quad \sin D/2 = \frac{50}{R} \quad \text{or} \quad D = 2 \sin^{-1} \frac{50}{R}$$

Formula 3.1

b. Maximum Curvature

The maximum degree of curvature allowed on main tracks is a function of design speed and the amount of superelevation - both actual elevation and unbalanced. Figure 3.1 illustrates the maximum curvature for a given design speed using both the preferred 1.5" as well as the maximum 2.75" unbalanced elevation combined with the maximum allowable 6" actual elevation. (See C.4.e. following for a discussion of superelevation)

Figure 3.1 based on following formulae from AREA:

$$E_a + E_u = 0.0007 \ DV^2$$

(See 4.e following for derivation of this formula) Formula 3.2

$$V = \sqrt{\frac{E_a + E_u}{0.0007D}}$$

Formula 3.3

or

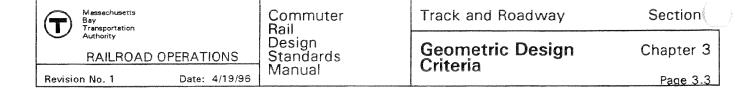
$$D = \frac{E_a + E_u}{0.0007 \, V^2}$$

Formula 3.4

V = Velocity in mph
D = Degree of Curvature

Ea = Actual Superelevation in inches
Eu = Unbalanced elevation in inches

Figure 3.1 following uses the maximum allowable 6 inches actual elevation (E_a)



Design Speed - MPH	Max. Curve with 1.5" Eu	Max. Curve with 2.75" Eu
40	6°-42'	7°-49°
50	40-17'	5°-00°
60	2°-59°	3°-28'
70	2°-11'	2°-33'
80 (79)	1°-43'	2°-00'
100	1°-04'	1°-15'

Figure 3.1

NOTE: Figure 3.1 will be modified if the FRA increases the currently mandated 3 inches maximum E, to a higher value.

Within station platforms, the maximum curvature shall be limited to as flat a curve as possible. On platforms on the inside of curves, the curvature shall not exceed $4^{\circ}-00^{\circ}$ to control gap from door to platform edge.

Within yards and terminals, sharper curves are allowed. Due to rolling stock restrictions, maintenance considerations and historical experience, the preferred maximum curvature on any track regularly used by 85 foot long passenger equipment is 11°-00°. Any curvature in excess of 12°-00° should be avoided as operation above that radius has been found to be unreliable.

c. Design Considerations

Curvature, superelevation, spiral lengths and design speeds are all interrelated. The goal in design is to combine those elements in a way that provides a comfortable and safe operating speed for the predominant traffic. When designing a new or upgraded segment of railroad, the designer should avoid a curve by curve approach, blindly applying the criteria to each curve to achieve maximum possible speed. This may result in a curve with superelevation sufficient for 79 mph bracketed by curves limited to 50 mph. Because trains take a very long distance to change velocity, especially above 35-40 mph, trains will run the 79 mph potential curve at 50 mph. This will result in passengers sensing an inward lean on the curve and cause excessive wear on the inside rail.

The most restrictive curve in a given section of railroad sets the speed for that section. The designer should investigate various means by which the restrictive curve may be modified to increase the speed to that of adjacent lesser restrictions. The cost and other factors should be assessed with Railroad

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Operations to determine what level of modifications could be justified or appropriate for each such location.

Signal aspects approaching interlockings may also be a factor in determining the line speed for a section of railroad. The designer should be aware of the locations of interlockings and inquire whether or not they will limit the maximum authorized speed for most trains in the approach area of the interlocking.

Often there are jurisdictional and safety issues that affect the design speed rather than civil restrictions based on geometry. An example would be a hazardous grade crossing which has a speed restriction imposed by the DPU.

Train performance calculation programs are a useful tool in analyzing line segments to determine what the practical maximum speed will be. By factoring in civil and jurisdictional restrictions and reviewing the results, it is possible to develop an overall design that will match the actual speed of most trains.

d. Concentric Curves in Multiple Tracks

In multiple track territory, when tracks follow the same general alignment, the tracks shall be concentric in curves. Track centers must be widened 2 inches per degree for curvature to maintain the equivalent tangent track center. The preferred method of increasing track centers is to lengthen the spirals of the inside track to a length where the spiral offset distance (p) relative to the outside track spiral (p) distance is increased by an amount equal to the required track center increase. The equivalent tangent track center is the nominal tangent track center for the route segment. When redesigning curves, strive to provide equivalent 14'-0" tangent track centers wherever possible, but in no case less than 13'-0".

e. Superelevation

Superelevation is expressed in terms of inches that the outside rail is raised above the level of the inside or low rail. Profile grade is always based on the low rail as superelevation is achieved by raising the outside rail relative to the inside rail.

There are three components to superelevation as used in railway design. It is essential that the use and relationship of these three components is understood.

$$E_e = E_a + E_u$$

(See following page for explanation of terms).

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Ee = Equilibrium Elevation
Ea = Actual Elevation
Eu = Unbalanced Elevation

Equilibrium Elevation (Ee) is the amount of elevation required on a given curve at a given velocity for centrifical force to be in equilibrium. That is, the resultant of the overturning force caused by the angular acceleration is directed perpendicular to the centerline of the elevated or "banked" track. When a train traverses the curve at the equilibrium speed, passengers will feel no sideways force and there is no tendency for the inside wheels to lift and the carbody to roll. (Figure 3.2)

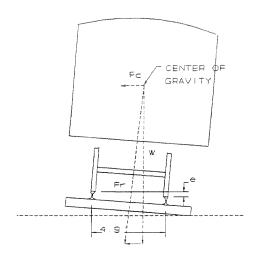


Figure 3.2

$$F_c = Wv^2/gR$$

Where: Fc = Centrifical Force

W = Weight of car in lbs.
v = Speed in feet per second

g = Acceleration due to gravity (32.16 ft/sec/sec)

Ř = Radius of curve in feet

Fr = Resultant force of Fc & W directed perpendicular to elevated track

e = Equilibrium superelevation in inches

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The formula derived from the proceeding used to determine equilibrium elevation on most passenger equipment is:

 $Ee = 0.000686 DV^2$ (usually rounded to)

 $Ee = 0.0007 DV^2$

Formula 3.5

0r $Ee = 4.01V^2/R$

Where:

= Equilibrium elevation in inches Ee

= Degree of curve D V = Velocity in mph R = Radius in feet

Unbalanced Elevation (Eu) is an equivalent amount of centrifical force which is not directed perpendicular into the track structure. A more descriptive term is cant deficiency. It has been found that a certain amount of deficiency in the elevation required for equilibrium is both safe and comfortable. For many years, the Federal Railroad Administration (FRA) has mandated that unbalanced elevation (cant deficiency) used in design and setting speed be limited to 3 inches for conventional passenger equipment. The MBTA currently uses a more conservative value for the amount of unbalanced (deficiency) elevation allowed, using 1.5 inches as the preferred limit and allowing up to 2.75 inches as a maximum. This provides improved passenger comfort, better compatibility with freight operations and a margin below the FRA mandated 3 inch maximum. Currently the 3 inch maximum Eu criteria is under review by FRA and an unbalanced elevation of 4 inches or more may be allowed in the future which would still provide a high level of safety and passenger comfort on well maintained track.

Actual Elevation (Ea) is the actual superelevation in track, limited to 6 inches. Based on the preceeding, the actual elevation required for a given curve is calculated as:

Ea = Ee-Eu

or. $Ea = 0.0007 DV^2 - Eu$

Formula 3.6

Where:

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Fa = Actual Superelevation in inches

= Degree of Curvature D V = Velocity in mph

= Unbalanced elevation in inches. Eu (1.5 inches preferred, 2.75" max).

Minimum and Maximum Superelevation

Minimum Ea shall be 1 inch. Maximum Ea shall be 6 inches except it is desirable to limit Ea to 4 inches on routes where through freights operate and where trains are likely to stop or operate below the design speed on a regular basis. Within stations it is

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desirable to limit Ea to 3 inches and use 2.75 inches Eu to allow express operation at maximum authorized speed.

Superelevation shall be developed uniformly through the length of transition spirals. Where spirals are not present or are of insufficient length, such deficiencies should be corrected as track is reconstructed. Running out of superelevation on tangents and curves is not permissable on medium to high speed routes and will be done only with permission of the Chief Engineering Officer. Proper spiral length is determined as discussed in the following sub-section.

Although calculated to the hundreth of an inch, actual superelevation in track is normally expressed and set in practice to the nearest one eight or one quarter inch.

f. Spirals

Spirals shall be used to connect all mainline curves to tangents. However, for practical considerations, spirals may be omitted when the required spiral length divided by the curve radius in feet is less than 0.01. Spirals shall also be used to connect compound curves whenever there is any change in Ea (actual elevation) or a change in Eu (unbalanced elevation) of 1/2 inch or more between the compound curves.

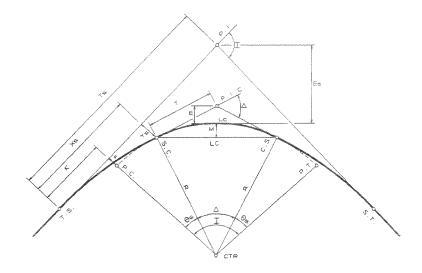
Spirals shall be a cubic parabola based on the so called "ten chord spiral" as shown in Figure 3.4. This is based on chord definition and is consistent with chord definition used with circular curves. The so called "Barnet Spiral", which is based on arc definition, will produce slightly different values.

Spirals shall increase in curvature directly with their length. Superelevation shall be increased uniformly over the length of the spiral reaching full Ea for the curve at the SC (spiral to curve point). The basic design data for spirals and curves is shown on Figures 3.3, 3.4 & 3.5.

In designing spirals and curves, determining the length of spiral (Ls) is a key element. There are three items that need consideration when determining the length of spiral:

- 1. The rate of run-in and run-out of the superelevation expressed in terms of inches per second, which affects passenger comfort.
- 2. The slope of the superelevated rail relative to the low rail. This results in a change in cross level between the two trucks of a car and should not exceed a l inch difference to prevent undue "racking" or torsional twisting of the car frame. This results in a tendency to lift the inside wheels of the lead truck. Continuned on Page 3.12

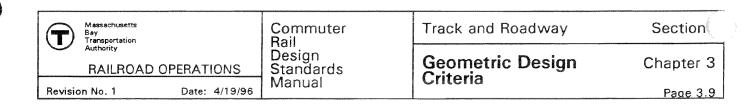
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<u>DEFINITIONS</u> Also See Figure 3.4

c.s.	CURVE SPIRAL, THE POINT OF CHANGE IN ALIGNMENT FROM CURVE TO SPIRAL	R	RADIUS OF CIRCULAR CURVE.
CTR	CENTER OF CIRCULAR CURVE	S.C.	SPIRAL CURVE, THE POINT OF CHANGE IN ALIGNMENT FROM SPIRAL TO CURVE.
D _c	DEGREE OF CURVE DEFINED BY THE 100 FT. CHORD DEFINITION	S.T.	SPIRAL TANGENT, THE POINT OF CHANGE IN ALIGNMENT FROM SPIRAL TO TANGENT
E	EXTERNAL DISTANCE FROM MIDPOINT OF CIRCULAR CURVE FROM P.I.C	Ť	DISTANCE FROM SC OR CS TO P.I.C. IN SPIRALED CURVE OR TANGENT FROM PC OR PT TO PI IN A SIMPLE CURVE
Es	EXTERNAL DISTANCE FROM CURVE TO P.I.	Ť.S.	TANGENT SPIRAL, THE POINT OF CHANGE IN ALIGNMENT FROM TANGENT TO SPIRAL.
I	ANGLE OF INTERSECTION OF MAIN TANGENTS AT P.I.	Ts	LONG TANGENT, DISTANCE FROM P.I. TO T.S. (OR P.I. TO
К	DISTANCE ALONG MAIN TANGENT FROM T.S. (OR S.T.) TO OFFSET P.C.		S.T.)
L	THE LENGTH OF EACH EQUAL CHORD	U	LONG TANGENT OF SPIRAL. DISTANCE FROM P.I.S. TO T.S. (OR P.I.S. TO S.T.)
ŗc	LENGTH OF CIRCULAR CURVE BETWEEN S.C. AND C.S. MEASURED ALONG 100 FT. CHORDS.	٧	SHORT TANGENT OF SPIRAL, DISTANCE FROM P.I.S. TO C.S. (OR P.I.S. TO S.C.)
LC	CHORD LENGTH OF CIRCULAR CURVE FROM S.C. TO C.S.	Xn	DISTANCE ALONG A MAIN TANGENT FROM T.S. (OR S.T.) TO OFFSET CHORD POINT N.
Ls	THE LENGTH OF SPIRAL FROM T.S. TO S.C. (OR C.S. TO S.T.) AS MEASURED ON TEN CONSECUTIVE EQUAL CHORDS.	Χs	DISTANCE ALONG MAIN TANGENT TO PERPENDICULAR OFFSET TO S.C. (OR C.S.)
М	MID-ORDINATE DISTANCE OF CIRCULAR CURVE.	Yn	OFFSET FROM CHORD POINT N TO MAIN TANGENT
n	A NUMBER BETWEEN 1 AND 10 USED TO IDENTIFY CHORDS.	Υs	PERPENDICULAR OFFSET FROM MAIN TANGENT TO C.S. (OR S.C.)
P	OFFSET FROM P.C. (OR P.T.) TO MAIN TANGENT.	⊖n	CHORD ANGLE. THE ANGLE BETWEEN THE MAIN TANGENT AND
P.C.	POINT OF CURVE, THE POINT OF CHANGE IN ALIGNMENT FROM TANGENT TO CIRCULAR CURVE. ON SPIRALLED CURVES THIS	0.,	CHORD N.
	POINT IS OFFSET A DISTANCE P FROM THE MAIN TANGENT.	⊖ _s	SPIRAL ANGLE, CENTRAL ANGLE OF SPIRAL.
P.I.	POINT OF INTERSECTION OF MAIN TANGENTS.	Δ	ANGLE OF INTERSECTION OF TANGENTS OF CIRCULAR CURVE
P.I.C	POINT OF INTERSECTION OF LINES TANGENT AT S.C. AND C.S.		ONLY
P.I.S.	POINT OF INTERSECTION OF MAIN TANGENT AND LINE TANGENT AT S.C. (OR C.S.)	MAIN TA	NGENTS - THOSE LINES TANGENT TO ALIGNMENT AT T.S. AND S.T. WHICH INTERSECT AT P.I.
P.T.	POINT OF TANGENCY, THE POINT OF CHANGE IN ALIGNMENT FROM CIRCULAR CURVE TO TANGENT, ON SPIRALLED CURVES THIS POINT IS OFFSET A DISTANCE P FROM THE MAIN TANGENT.		

CURVE WITH SPIRALS AND DEFINITIONS FIGURE 3.3



1.
$$D_c$$
 = 2 ARCSIN $\frac{50}{R}$ R = $\frac{50}{SIN D/2}$

2.
$$\Theta_s = \frac{L_s D_c}{200}$$

$$3. \quad L = \frac{L_s}{10}$$

4.
$$\Theta_n = \frac{3n^2 - 3n + 1}{300} \Theta_s$$
 $n=1, ... 10$

5.
$$X_n = L \sum_{n=1}^N \cos \Theta_n \quad n=1, \dots 10$$

6.
$$Y_n = L \sum_{n=1}^{N} SIN \Theta_n \quad n=1, \dots 10$$

7.
$$X_s = X_{10}$$

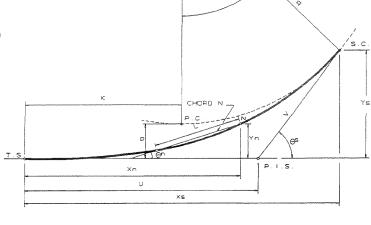
8.
$$Y_s = Y_{10}$$

9.
$$P = Y_s - R(1 - COS \Theta_s)$$

10.
$$K = X_s - R SIN \Theta_s$$

11.
$$U = X_s - \frac{Y_s}{TAN \Theta_s}$$

12.
$$V = \frac{Y_s}{SIN\Theta_s}$$



NOTES:

- Spiral criteria shown is for spirals between tangents and
- For definitions, see Figure 3.3

13.
$$\Delta = I-2\Theta_s$$
 (WHEN BOTH SPIRALS ARE OF EQUAL LENGTH)

14.
$$T = R TAN \frac{\Delta}{2}$$

15.
$$L_c = 100 \frac{\Delta}{D_c}$$

16.
$$E = R\left(\frac{1}{COS\frac{\Delta}{2}} - 1\right)$$

17.
$$LC = 2R SIN \frac{\Delta}{2}$$

18.
$$M = R\left(1 - COS\frac{\Delta}{2}\right)$$

19.
$$T_s = K + (R + P)$$
 TAN $\frac{I}{2}$ (WHEN BOTH SPIRALS ARE OF EQUAL LENGTH)

20.
$$E_S = \frac{T_S - K}{SIN\frac{I}{2}} - R$$
 (WHEN BOTH SPIRALS ARE OF EQUAL LENGTH)

SPIRAL AND RELATED FORMULAE FIGURE 3.4



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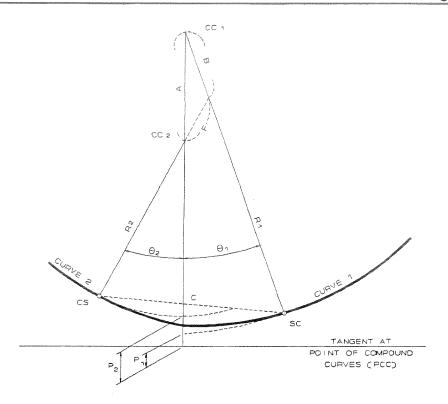
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$$\Theta_1 = \frac{DC_1 \times L_S}{200}$$

$$\Theta_2 = \frac{DC_2 \times L_S}{200}$$

$$A = (R_1 - R_2) - (P_2 - P_1)$$

$$B = A SIN \ominus_2 / SIN (\ominus_1 + \ominus_2)$$

$$F = A SIN \ominus_1/SIN (\ominus_1 + \ominus_2)$$

$$C^2 = (R_1 - B)^2 + (R_2 + F)^2 - 2(R_1 - B)(R_2 + F) COS(\Theta_1 + \Theta_2)$$

K = RATE OF CHANGE IN DEGREE OF CURVE

$$K = \frac{100 (DC_2 - DC_1)}{LS}$$

$$P_n = Y_s - R(1 - COS\Theta_n)$$

COMPOUNDING SPIRAL FIGURE 3.5

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3. Lateral acceleration increase and decrease induced by the onset and then release of centrifical force caused by unbalanced superelevation when entering and leaving curves should be kept to low values for comfort. This acceleration rate is generally accepted to be 0.03 g/sec.

The first item (rate of superelevation run-in) is generally recommended to be 1-1/4 inches/sec for speeds up to 60 mph, 1-1/6 inches/sec from 60 to 80 mph and 1-1/8 inches/sec from 80 to 100+ mph. This can be expressed as:

Ls=1.17 Ea V (1-1/4"/sec) Ls=1.26 Ea V (1-1/6"/sec) Ls=1.30 Ea V (1-1/8"/sec)

The second item is a function of the truck spacing of an 85 foot long car. That dimension is typically 59'-6" for an 85' long car, however 62' is the figure used.

Ls=62 Ea

It has been normal practice to express elevation run-in in terms of inches per 31 foot chord (the usual stringlining interval). A run-in of 1/2 inch per 31' is typically used up to 50 mph and 3/8 inch per 31' from 50 to 80 mph and 1/4 inch per 31' from 80 to 100+ mph.

The following rates provide an expedient way of satisfying the first two items:

Ls=62 Ea Up to 50 mph Ls=83 Ea 51 to 80 mph Ls=124 Ea 81 to 110 mph

The third element - lateral acceleration increase - is expressed by the formula:

Ls=1.63 EuV (produces a lateral acceleration of 0.03g/sec)

In "tight" situations a shorter spiral is permitted:

Ls=1.22 EuV (produces a lateral acceleration of 0.04g/sec)

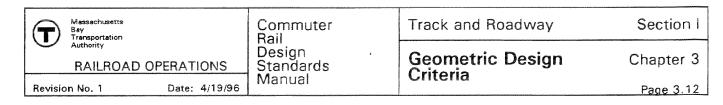
Summarizing: the minimum spiral length should be determined by using the longer result of the two following criteria:

1. Ls=62EaV \leq 50 mph Ls=83Ea 50 < V \geq 80 mph Ls=124Ea 80 < V \geq 110 mph

Formula 3.7

2. Ls=1.63 EuV (whenever possible)
Ls=1.22 EuV (in "tight" situations)

Formula 3.8



The minimum length of spiral shall be 100 feet in mainline track. A spiral of 62 feet is permitted in secondary track as a curve easement and when superelevation is not over one inch.

g. Gauge Widening in Curves

The MBTA does not normally widen track gauge in curves on commuter rail. However, in certain instances it may be beneficial to consider widening gauge 1/8" per degree of curve in excess of 10 degrees up to a maximum of 4'-9 1/8". This should be discussed with Railroad Operations on a site specific basis.

5. Vertical Alignment

a. General

Railroads are very sensitive to gradient due to very low power to weight ratios and frictional limitations imposed by the adhesion of steel to steel. For these reasons, as well as general safety and economy, grades must be kept to a minimum. Vertical curves connecting changes in gradient must be gradual, long enough to prevent coupler slack action run-in and run-out in long freight trains from generating forces great enough to break the couplers and separate the train or buckle the train. Passenger trains are normally not subject to slack-action problems. Operating at high speed, vertical curves need only to be long enough to prevent passenger discomfort caused by relatively small vertical g forces. However, good design dictates that more conservative values be used that will fit the available space, especially if through freight service is operated.

b. Maximum Grade

. Maximum Grade⁴ 0.70% Preferred Max. 1.50% Absolute Max.

- . Maximum Grade at Stations 0.50% Preferred Max. or any locations where trains 0.75% Absolute Max. may stop on a regular basis
- Maximum Grade at Maintenance 0.00% Preferred Max. Facilities & Unattended Stor- 0.25% Absolute Max.⁵ age Yards

The ruling or maximum grades on a section of railroad must be compensated for the increased resistance caused by curvature by

 $^{^{5}}$ If steeper grades are required - derails and other protection from rolling should be considered.

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 $^{^4}$ Under very special conditions a grade up to 3.00% is permissible with permission of the Chief Engineering Officer

reducing the grade through the curve by 0.04 percent per degree of curvature.

c. Minimum Length of Constant Grade

Frequent changes in gradient are to be avoided. Eliminate grade changes wherever physically and economically possible.

Minimum Length of Tangent Grade 200 Feet Absolute Min. Length of Tangent Grade 75 Feet

d. Vertical Curve Length

The only generally recognized criteria used by railroads for 100 years in determining the length and corresponding rate of change of a vertical curve is in the AREA, Manual Chapter 5, Part 3, Section 13 which gives the required rate of change as 0.05 feet per 100' station in sags and 0.10 feet per station in summits. Up to twice that rate is possible in track of "lesser importance". This criteria is currently under review by AREA Committee 5 and it appears that a considerable reduction in the required vertical curve length recommended by AREA is forthcoming.

Experience has shown that application of the current AREA criteria in the MBTA's Commuter Rail Territory will often require vertical curves far too long to fit either existing or new conditions. The current AREA criteria's very low rate of grade change is to control the "accordion effect" that occurs in long freight trains which generally have about one foot of slack between each car. This slack is needed to start heavy trains as it would be impossible to start the entire train all at once. This slack creates adverse train handling conditions and high buffing and draft forces on undulating profiles with short vertical curves. These forces can contribute to breaking a train apart or buckling the cars. Considering only passenger equipment, which has little slack between cars and fewer units than a long freight, much shorter vertical curves would not affect train buffing and draft forces, the primary concern being passenger comfort. Even very slight gravitational ("g") forces in a vertical plane produce a "queasy" feeling in many passengers.

The following criteria is suggested in determining the minimum length of vertical curve in main track. This criteria is more conservative than the revised AREA criteria currently under consideration.

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$$L=0.05 (G_1-G_2)V^2$$

Formula 3.9

Where:

L = Length of vertical curve in feet.

 G_1-G_2 = Net or algebraic difference of the grade

change in percent.
V = Velocity in mph.

AREA criteria currently under consideration:

$$L = 0.036 (G_1 - G_2) V^2$$

The rate of change in grade per 100 feet is the way the "sharpness" of vertical curves are usually expressed.

$$r = \frac{G_1 - G_2}{L} \times 100$$

Formula 3.10

Where:

r=rate of change in %/100'

Following is a summary of various vertical curve criteria:

Current AREA Criteria

Rate of Change %/100'

(Double rates if necessary)

0.05% Sags 0.10% Summits

Northeast Corridor (Amtrak) criteria - 1970's

0.30% Summits & Sags

"Suggested" MBTA criteria:

$$I = \frac{2000}{V^2}$$

Formula 3.11

(r not to exceed 0.80%/100')

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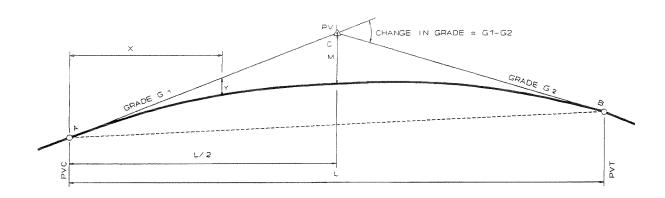
AREA Revision Under Consideration

$$r = \frac{2800}{V^2}$$

Formula 3.12

(r not to exceed 1.12%/100')

Unless otherwise directed, use Formulae 3.9 and 3.11, limiting rate of change to 0.80% per 100 feet. (Also see part "g" following).



Vertical Curves

Figure 3.6

Vertical curves shall be parabolic and have the following mathematical characteristics:

$$M = \frac{L/100 \ (G_1 - G_2)}{8}$$

Formula 3.13

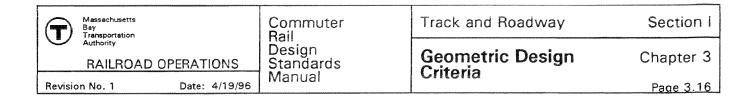
$$Y = \left(\frac{X}{L/2}\right)^2 \times M$$

X cannot exceed L/2. Leftside of curve, use point A as origin for X. Right side of curve, use point B as origin for X.

Formula 3.14

$$L = \frac{G_1 - G_2}{r} \times 100$$

Formula 3.15



Elevation of V.C. at any point =
$$\left(\frac{r}{2}\right)\frac{x^2}{100} + G_1 \frac{x}{100} + PVC$$
 Elev.

Where:

M = Mid ordinate of vertical curve at PVI

Y = Offset from tangent to vertical curve at any point on curve in feet

X = Any distance from PVC in feet

L = Length of vertical curve in feet

 G_1 = Grade at PVC, in % G_2 = Grade at PVT, in %

r = Rate of change in grade in %/100'

e. Vertical Curves Within Turnouts

It is good practice to avoid vertical curves in turnouts. When this is not possible, vertical curves may be introduced through turnouts with the following restrictions:

1. Keep vertical curves flat enough so that calculated vertical mid ordinate through the entire length of frog is 1/32 inch or less.

This results in the following maximum permissible rates of change: Halve these rates in summit curves in switch area of turnout. This is in deference to concern that the switch points be forced upward - even slightly.

		Sag. Curves	<u>Summit Curves</u>
No. 8 T.O.	_	0.50%/Sta.	0.25%/Sta.
No. 10 T.O.	_	0.35%/Sta.	0.18%/Sta.
No. 15 T.O.	mad	0.25%/Sta.	0.13%/Sta.
No. 20 T.O.		0.15%/Sta.	0.08%/Sta.

- 2. In yards or low speed areas where higher rates of change and shorter vertical curves may be necessary, vertical curves may be confined to the closure area of the turnout, the area between the switch and frog.
- f. Minimum Length of Vertical Curve

Vertical curves shall not be less than 100 feet long on main lines. Curves with a calculated mid-ordinate less than 1/4 inch (0.021 feet) are too inconsequential to lay out in the field and maintain. Such vertical curves should be avoided by either lengthening the curve or using a vertical angle point when the algebraic difference of the grades is 0.10% or less.

Within yards and low speed areas such as servicing areas and

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approaches to stub end terminals, vertical curves may be shorter than 100 feet and have rates of change in excess of 0.80%/100 feet, but never so short as to produce a vertical curve sharper than an equivalent radius of 4,000 feet as determined by the formula:

Equivalent Radius⁶ =
$$\frac{L}{G_1 - G_2} \times 100$$

Formula 3.17

Where:

L = Length of vertical curve in feet $<math>G_1-G_2 = Difference in connected grades in percent$

g. Combined Horizontal and Vertical Curvature

Another consideration in the design of both horizontal and vertical curves is the combined effect of "g" forces resulting when both horizontal and vertical curves are combined. The horizontal forces are discussed in Section 4 of this chapter and are related to lateral acceleration forces developed through the spiral and centrifical force from cant deficiency. Generally, the combined effect is not significant except when one or the other or both are at or near their maximum allowable value. In either case, the following check should be made and the design adjusted as required.

In locations where horizontal curves are the controlling factor the rate of change of grade (r) which may be allowed to act concurrently shall be determined by the following formula:

$$r = \frac{2000}{V^2} (1-0.33Eu) (1-0.018Ee)$$

Formula 3.18

Where:

r = Rate of change of grade in percent/100' Station.

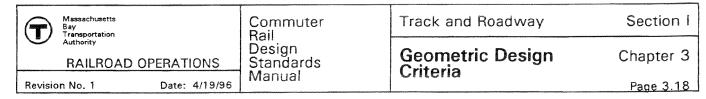
v = Velocity in mph.

Eu = Unbalanced Elevation of Horizontal Curve
Ee = Calculated Elevation for Equilibrium.

D = Curvature in Degrees

In locations where vertical curves are the controlling

Note that "equivalent radius" formula calculates a circular curve, not parabolic as an actual vertical curve is. Parabolic curve is flatter on both ends and somewhat sharper opposite the PVI than equivalent radius curve. Formula 3.17 provides an expedient way of determining relative sharpness of vertical curves.



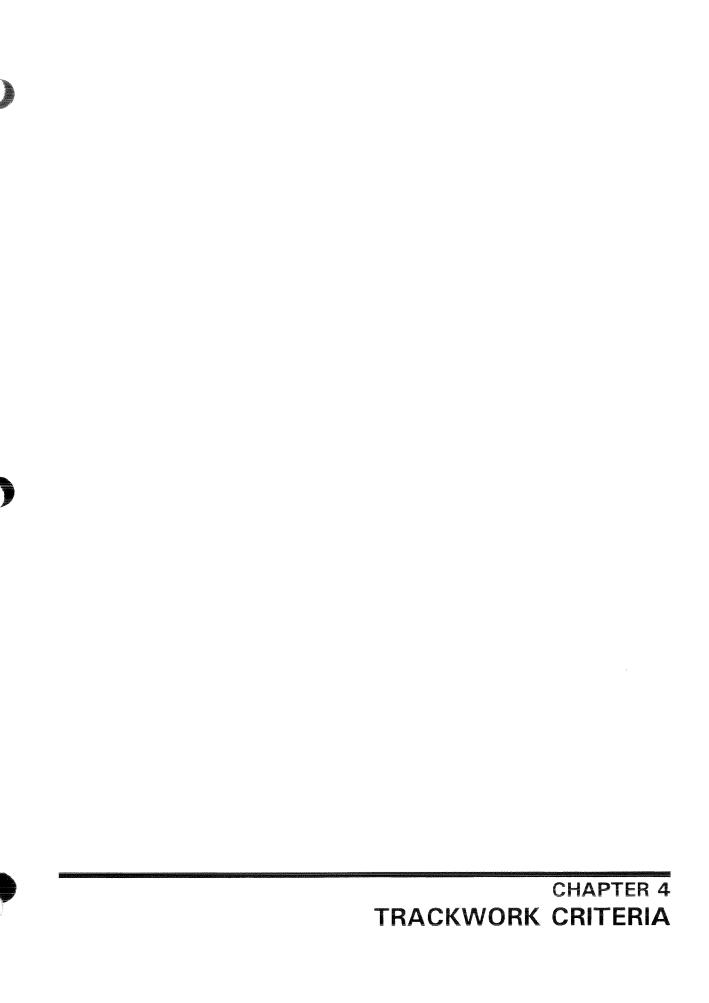
factor, the unbalanced superelevation Eu allowed to act concurrently shall be determined by the following formula:

$$Eu = (3.00) \left(1 - \frac{rv^2}{2000 (1 - 0.0000126 V^2 D)} \right)$$
 Formula 3.19

Note: If a negative number is produced by above formula, either ${\it V}$ or ${\it r}$ must be reduced until a positive number is obtained.

This combined effect is not an issue with current AREA vertical curve criteria. Whenever the "suggested" criteria or "currently under consideration" AREA criteria is used, the combined horizontal/vertical effect should be investigated, and adjusted accordingly per above formulae.

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A. General

All track materials and special trackwork shall conform to the current MBTA "BOOK OF STANDARD PLANS - TRACK AND ROADWAY" and the "MATERIAL SPECIFICATIONS" which are referenced as appropriate.

All new installations or track renewals shall be with resilient fasteners on either timber or concrete ties as directed by the Chief Engineering Officer.

Ballasted track construction will be used at all locations except on bridges, viaducts, subways and tunnels, where direct fixation track construction may be used when directed by the Chief Engineering Officer.

New open deck bridges shall not be permitted except on a temporary basis. Existing open deck bridges shall be rebuilt to ballasted deck or direct fixation wherever possible.

Main track subgrade shall be designed to the dimensional requirements of Standard Plans 1000 and 1002 and as defined in Chapter 5 of this Manual.

B. Rail

Reference Material Specifications No. 9233 & 9236. Reference Standard Plans - 1300 & 1302.

The standard MBTA rail section for new construction is 132 RE continuous welded rail. 115 RE CWR may be used in certain applications only when directed by the Chief Engineering Officer. Suitable, available fit relay rail sections, either CWR or bolted, may be used when replacing secondary tracks as and when approved by Railroad Operations.

Standard control cooled rail shall be used on all main line track with curves up to and including $2^{\circ}-00^{\circ}$. Fully heat treated rail shall be used on all main line curves where curvature is in excess of $2^{\circ}-00^{\circ}$. Carry heat treated rail through spirals and through tangents between adjacent curves over $2^{\circ}-00^{\circ}$ wherever the tangent is less than 300 feet long.

Fully heat treated rail shall not be used in curves outside of main lines, unless specifically directed.

Fully heat treated rail shall be used within all turnouts and other special trackwork units.

All rail shall be weldable by either electric flash-butt or thermite process.

C. Timber Cross Ties

Reference Standard Plans - 1100, 1104, 1106 and 1108 Reference Material Specification - 9209

Transition ties shall be used in areas of changing track modulus as shown on Standard Plan 1108.

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Timber cross ties shall be spaced at 19-1/2 inches except use 18 inches within grade crossings. Within full depth rubber crossings, 9'-0" long ties shall be used.

Material specifications, seasoning and other requirements to be as specified in No. 9209.

D. Concrete Ties

Reference Standard Plan - 1120

Concrete tie are increasingly being used on the MBTA system. Use on a specific route/project shall be determined by the Chief Engineering Officer. Standard tie spacing for concrete ties is 24".

E. Subballast

Reference Standard Plans - 1000 & 1002 Reference Material Specification - 9251

Subballast shall be used on all new track construction or major reconstruction when the underlying material is not clean, free draining, well graded, granular material. The typical section shown on the standard plans should be considered adequate only for fair to moderately good subgrade conditions. If there is a history or direct evidence of difficulty in maintaining good surface and line at an existing track location or, if on new location, test borings indicate any condition other than good, granular material; the designer should recommend measures to provide adequate support for the track structure, including a change from the 8 inch depth of subballast shown on the typical sections. Additional discussion of subgrade treatments is found in Chapter 5, Roadway Criteria.

F. Ballast

Reference Standard Plan - 1000 & 1002 Reference Material Specification - 9248

Crushed stone ballast per the referenced material specification shall be used on all trackwork. 12 inches depth under bottom of tie is the mainline standard. Ballasted deck bridges should also have 12 inches of ballast under the tie with 8 inches minimum when conditions warrant and when approved by the Chief Engineering Officer.

Maintenance of adequate ballast shoulders of 18" beyond the end of tie and good ballast compaction is essential to track stability and to control track buckling. All projects involving track reconstruction or realignment of track must provide construction specifications and phasing plans which both enforce and enable the proper preparation and compaction of the ballast section prior to opening track to service.

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G. Tie Plates

Reference Standard Plans 1220, 1222, 1224 & 1225 Reference Material Specifications - 9269 & 9272

Tie Plates shall be used on all tracks regardless of use.

The MBTA standard for new timber tie track construction is resilient fastener plates with lock spikes. Within turnouts - either with tropical hardwood or treated oak - plates shall be fastened with screw spikes.

Cut spike tie plates shall not be used on new construction or track renewal projects unless specifically directed by the Chief Engineering Officer.

H. Spiking

Reference Standard Plans - 1104 & 1230 Reference Material Specifications - 9274 & 9275

Spiking patterns within standard timber and ballasted track construction shall be as per Standard Plan 1104. Within turnouts, screw spikes shall be used throughout as follows:

Gage Plates 6 screw spikes per plate Shoulder Slide Plates 4 screw spikes per plate 4 screw spikes per plate Adjustable Brace Slide Plates Heel Plates 4 screw spikes per tie per plate. Frog Tie Plates/Self Aligning Shoulder Plates 2 screw spikes per plate All Standard Plates within Turnout 4 screw spikes per plate Guard Rail 4 screw spikes per tie per guard plus 2 drive screw spikes per rail seat.

Holes for lock spikes shall be pre-drilled 9/16" dia. x 6" deep and 11/16" dia. x 6" deep for screw spikes. Holes not used, shall be plugged with treated or cedar tie plugs. Within turnouts using tropical hardwoods, pre-drill spike holes at gauge side of both switch points to allow spiking switch out of service with a cut spike. Plug such holes with cork tie plugs.

I. Rail Anchoring

Reference Standard Plan - 1232 Reference Material Specifications - 9239 & 9242

Anchoring patterns shown on Plan 1232 are for cut spike fastened tracks only. Track using the standard resilient fasteners does not require additional anchoring unless specified by the Chief Engineering Officer.

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J. Resilient Fasteners

Reference Material Specification - 9245

Resilient fasteners and matching tie plates shall be used on all new installations and track renewal projects. In addition to the standard plate used on timber ties and rag stem inserts, tie pads and insulators used on concrete ties, there are other systems to be considered in certain applications. These applications include direct fixation slabs and possibly open deck bridges. Impact attenuating, composite tie plates with provision for holding the rial with the standard resilient fastener are a system to be considered where appropriate.

K. Special Trackwork

Reference Standard Plans 2000 to 2499 Reference Standard Specifications - 9278, 9281, 9284 & 9287

Unless otherwise directed, use "floating heel block" design turnouts as detailed on the Standard Plans.

No. 20 turnouts shall be used for mainline crossovers and junctions of diverging mainlines wherever there is sufficient room. Allowable design speed for the Standard No. 20 turnout is 45 mph through the curved side of turnout. No. 20 equilateral turnouts may be used at ends of double track and such locations where they may be used to advantage. Allowable design speed through both legs of a No. 20 equilateral turnout is 65 mph (2.75 inches unbalanced elev.). With authorization of the Chief Engineering Officer, a speed of 70 mph may be used (3 inches unbalanced elev.).

No. 15 turnouts shall be used for mainline crossovers where there is insufficient room for No. 20's or where the design speed is limited to 30 mph or less because of other civil restrictions. No. 15 turnouts shall also be used to connect secondary lines and primary yard leads to the main line. Allowable design speed for the standard No. 15 turnout is 30 mph through the curved side of the turnout. No. 15 equilateral turnouts may be used where feasible. Allowable design speed through both legs of a number 15 equilateral is 50 mph (2.75 inches unbalanced elev.)

No. 10 turnouts shall be used for all sidetrack connections to the main line and all yard leads and yard tracks wherever possible. The No. 10 turnout is the preferred minimum size turnout for any commuter rail application. The maximum allowable design speed through the curved side of the standard No. 10 turnout is 20 mph, however, 15 mph is the preferred maximum for safety and maintenance considerations.

No. 8 turnouts shall be used only within yards and servicing facilities, only when it is physically impractical to fit No. 10's and only with permission of the Chief Engineering Officer. The maximum allowable design speed through the curved side of the Standard No. 8 turnout is 15 mph, however, 10 mph is the preferred maximum for safety and maintenance considerations.

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Turnouts shall have 5 inch hot mix asphalt underlayment installed per MBTA Standard Plan No. 1030 and as indicated in Chapter 6, Section A4.

L. Switch Stands

Reference Standard Plans - 3020, 3023 & 3030 Reference Material Specification - 9257

Manual switch stands on mainline turnouts shall be intermediate height-model Racor 17D or New Century 50-B with operating rod sufficient to provide required side clearance and mounted on 16'-0" long headblock timbers. Electric lock is required on any installation in signal territory. Racor moded 17D or New Century 50-B shall also be used in yards where there is sufficient room for the 16'-0" headblocks.

Low stands - Racor model 36D or New Century Model 50A - shall only be used in yards and terminals where there is limited side clearance. Do not use in main track without specific authorization of the Chief Engineering Officer.

The Racor Style 22 is a "run through" type mechanism allowing automatic operation of trailing point movements through either leg of the turnout regardless of switch position. Use only in yards and servicing areas as directed by the Chief Engineering Officer.

All switch stands shall be furnished with the MBTA Standard Red/Green switch stand target unless specifically directed otherwise.

M. Bumping Posts

Reference Standard Plan - 3010 Reference Standard Specification - 9206

A steel, model "WA" bumping post per referenced standards shall be installed on all stub end tracks subject to operation (either revenue or non-revenue) by commuter rail equipment. Tracks used only for dead storage or work equipment storage may have other types of bunters. End of line stub end terminals will have energy absorbing impact attenuators capable of disapating energy equivalent to a nine car & one locomotive consist travelling at 10 mph. This requirement may be waived by the Chief Engineering Officer at locations where there is insufficient room and/or there are no buildings or structures in the path of a train which overshoots the end of track.

N. Emergency Guard Rails

Reference Standard Plans - 3060 & 3062 Reference Material Specification - None

1. Bridges

Guard rails (double rail) shall be used on all through girder and through truss bridges regardless of the span length and on any bridge when the structure length between abutment backwalls is over 40 feet.

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Resiliently fastened guard rail as detailed on Standard Plan 3062 shall be used on all ballasted deck bridges and approaches and ballasted approaches to open deck bridges to aid in removal and reinstallation during surfacing operations.

The 39'-0" end approach section shall be lengthened at design speeds in excess of 60 mph as follows:

Length of guard rail end approach = 0.74V

V = design speed in mph.

2. Other hazardous locations

Single rail guard rails and/or crash walls may be used at such other locations where a derailment would cause significant structural damage to adjacent, vulnerable structures or to the railroad's equipment. Examples where such installations may be considered include:

- a. Adjacent to steep drop-offs to water or where derailment would cause significant damage from the length of potential fall.
- b. Adjacent to near-by high voltage structures.
- c. Adjacent to any supporting column of an overhead bridge or structure which if struck by a train would very likely cause catastrophic failure of the structure. A crash wall may be appropriate in such cases. See Section "N" below.

0. Crash Walls

When tracks are immediately adjacent to supports for bridges, buildings and air rights development over the right-of-way, consideration must be given to protecting supporting structures from impact of a train in event of derailment.

The impact design loading for crash walls shall be as follows:

- Train weight, 1,666,000 lbs consisting of locomotive at 280,000 lbs and nine coaches-fully loaded at 154,000 lbs each.
- The angle of attack (measured from tangent to the track) shall be ten degrees.
- The impact speed shall be authorized track speed at the location plus a 50 percent safety factor.
- Place piers and abutments at such an angle that a square hit is not possible. Provide "wing" or angled section to deflect train away from blunt ends.

Refer to AREA Manual Chapter 8 for additional considerations with respect to crash walls.

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P. Derails

Reference Standard Plans - 3000, 3004, 3006 & 3007 Reference Material Specifications - 9215

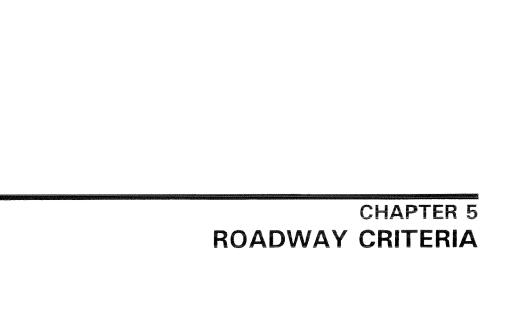
Split switch derails shall be used on all side tracks which connect to the main line with a descending grade.

Where less positive protection is required, sliding block derails may be used as directed by the Chief Engineering Officer.

Hinged block type derails shall be used only on engine house ready and storage tracks when power operated derails and interlocked blue flag protection is not available.

Derails used to protect main lines in signal territory must include circuit controllers, insulated joints and connections to signal system. If necessary, provide for sign installation - "Siding not to be used to clear main line".

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A. SUBGRADE

1. General

The trackbed cross section will be designed to the dimensional requirements of Standard Plans 1000 & 1002. The minimum subgrade cross slope should be 1/4 inch per foot to facilitate the removal of water from under the track structure. Final subgrade elevation in either cuts or fills shall be set to allow placement of design trackbed section at design profile grade. The section shown on the Standard Plans will be used only when existing subgrade conditions are satisfactory. Design of trackbed section in poor subgrades and design of additional measures to provide a stable and maintainable track structure shall be responsibility of the designer.

At existing track locations, when track renewal is planned, the designer must investigate the following to determine the need for additional subgrade preparation.

- a. Inspect track structure and note any areas with obvious problems such as muddy, fouled or pumping track, poor surface and alignment, wet conditions, instability in slopes supporting or above the trackbed, gullying or potential washouts, ditches and pipes filled or partially filled with silt or clay and trees or other vegetation which could undermine track bed if dislodged.
- b. Interview maintenance personnel to determine any locations that are difficult to maintain or have a known history of stability or drainage problems.
- c. Recommend and observe cross track test pits at any locations suspected of poor subgrade conditions.
- d. Recommend and observe a soils boring program as required for any locations where a major subgrade problem is suspected.

At new track alignment locations, test borings, test pits or other suitable means should be included as a part of the design process to determine the nature and depth of soil strata that will be supporting and draining the track bed.

Hot mix asphalt underlayment shall be installed under all new turnouts and grade crossings per Standard Plans. Composition of mix shall be as indicated in Part 4 of this heading of "Subgrade".

2. Fill Sections

New fill foundations must be explored and then designed to prevent failure of the subsoil or excessive settlement. The exploration program should be developed and carried out as detailed in the AREA Manual - Chapter 1, Part 1.1. Use of sand or wick drains and

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surcharging may be necessary to consolidate compressive soils prior to final construction.

When widening existing fills, benching the existing slope and placing new fill in compacted lifts not over two to three feet in depth must be detailed in the plans and specifications. Simply dumping material down the slope is not permissible except for shallow fills (less than 5 feet high) or when dumping stone rip-rap for erosion control. Existing culverts, including equalizing culverts, should be investigated, protected or extended as necessary prior to widening fill sections.

3. Cut Sections

Cut sections pose particular problems related to drainage and soil stability. Within existing cuts it is imperative that the side ditches be cleaned, enlarged and lowered to a depth not less than four foot six inches below top of rail. Ditches should also be graded to drain. Where ditches of sufficient depth and cross section are not possible, underdrains and closed drainage systems must be provided.

Visually inspect all cut slopes for signs of instability and excessive moisture which could lead to instability. If widening of cut slopes is indicated, investigate stability of slope and recommend construction methods and materials necessary to maintain slope stability. Top of cuts must be inspected for water retention or ponding areas caused by low points, beaver dams, etc. and methods to remove water away from the cut detailed.

The track bed within existing cuts often is composed of non-granular material which fouls ballast quickly and does not allow water to drain. This condition should be remedied as much as possible during track renewal projects. Excavation of unsuitable material, additional underdrains, placement of hot mix asphalt underlayment, geotextiles, are some of the methods that may be considered in various combinations to improve roadbed stability and lower the cost of maintenance.

4. Hot Mix Asphalt Underlayment

Hot mix asphalt underlayment (HMA) shall be installed as subgrade under roadway crossings and turnouts as shown on Standard Plans 1030, 3100, 3106 and 3108. HMA may also be installed under normal track where subgrade conditions are poor.

The recommended job mix formula for HMA underlayment shall be as specified in MBTA Standard Specification 02513, Table 02513-c supplemented by the following table:

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Standard Sieves	Underlayment Mix (HMA)
2" 1-1/2" 1" 3/4"	100 90 - 100
1/2" 3/8" No. 4 8 16 30	56 - 80 29 - 59 19 - 45
50 100 200 Bitumen	5 - 17 1 - 7 3 - 9

Table 5.1

HMA mix shall be installed in one course using sufficient material to provide a compacted mat 5 inches thick.

B. DRAINAGE

1. General

Drainage in stations and landscapped areas is also discussed in Section II, Chapter 6, Landscapping.

Good drainage and it's maintenance are absolutely essential to the safe and economical operation of a railroad. Safety is of paramount concern and certain drainage related problems can result in failure of either the roadbed or structures. During the design of both new facilities and reconstruction of existing, it is essential that close attention be paid to roadbed drainage, cross culverts and structures over water courses.

In designing for removal of surface and groundwater from the trackbed section, the following general conditions shall apply:

- . Existing drainage patterns shall be maintained wherever possible.
- . To the maximum extent possible, surface and subsurface drainage of the roadbed should be handled by a system of gravity flowing longitudinal ditches that feed into catch basins, transverse ditches or streams. Ditches should be designed to handle anticipated flows without silting or scouring.
- Low points in ditches should be avoided but when required, positive means of removal of water must be supplied at the low points. Those means may include tieing into municipal storm

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sewer systems by use of catch basins, leaching basins or groundwater recharge ponds (if permitted by subsurface geology and local ordinances), transverse ditches, culverts and natural or artificial watercourses.

- When absolutely necessary, where gravity outfalls are impractical, pumps may be considered to ensure positive drainage. In such instances, the design flow shall include an allowance for groundwater infiltration as appropriate.
- Drainage systems that discharge to an existing wetland or are within 100 feet of a wetland must comply with the rules and regulations of the Wetlands Protection Act and local bylaws. The local conservation commission must be contacted and informed of project details and probable wetland impacts. The commissions issue "Orders of Conditions" which should be incorporated into the design. Conservation commissions may also require an EIR or FIS.
- Drainage systems connecting to an existing storm drain must also comply with the Wetlands Protection Act if it discharges to a wetland. Approval is also required from the drainage system owner. The owner should be contacted early in the design process to determine their specific requirements.

Mainline Trackbed Drainage Criteria

- a. Do not drain subgrade from one track across or towards an adjacent track. The area occupied by each track should drain to its own ditch or subdrain.
- b. Do not drain areas from beyond the track bed through the track structure. Typically, a ditch or subdrain should lie between the track and the adjacent ground area to intercept fines from an adjacent slope which would foul the ballast.
- c. At locations where there will be a future track, crown the subgrade on the centerline between the tracks. Where practical, keep the ditch or subdrain on the field side of the future track clear of the future track so it doesn't have to be changed later.
- d. Typical drainage pattern for double track roadbed section is from a crown between the tracks to a ditch or subdrain on the field side of the tracks. When double track is between walls a single subdrain may be located between the tracks. "Walls" may include a retained cut or a retained fill where the walls are too close to the tracks to allow ditches or subdrains.
- e. Typical drainage pattern for single track is a crown line on the centerline of the track to ditches or subdrains on each side. When a single track is between walls, the ditch or subdrain may

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be located on one side and the subgrade sloped in one direction to the ditch or underdrain.

- f. At <u>side</u> platform stations, the platform should drain away from the track. A subdrain should be placed between the track and the platform to drain half of the track bed, and any water from platform canopies or areas behind the platform that are not handled by other site drainage. If there is a wall on the opposite side of the track from the platform, the entire track area should drain to the subdrain lying between the track and platform.
- g. At <u>island</u> platforms, the platform should drain into the track area to avoid ponding at the center of the platform. Subdrains should be placed between track and platform so that track drainage is handled the same way as at a side platform station.
- 3. Design Considerations
 - a. Design Storm Computation
 - 1. Rational Equation:

Design flows for local drainage shall be computed by the Rational Equation:

Q = CIA

Formula 5.1

where:

Q = Runoff quantity, in cfs C = Coefficient of Runoff

I = Rainfall intensity, inches/hour

A = Drainage area, in acres

2. Design Frequency:

The track drainage system including all open track bed areas exposed to direct precipitation shall be designed to accommodate the peak flows produced by the 50 year rainfall event. All runoff shall be fully contained within the drainage system, no surcharge will be allowed for undepressed catch basins and the capacity of all pipes, ditches, etc. shall equal or exceed the 50 year runoff. In addition, the storm drainage system shall be designed to maintain a maximum water level 18" below top of tie during the 100 year rainfall event.

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The drainage systems for non mainline track areas such as parking lots, station accessways and layover facilities shall be designed to accommodate flows produced by a 10year storm unless otherwise specified by regulatory authorities. The capacity of the receiving storm-drain system shall be investigated to determine if there is adequate capacity to comply with this requirement.

3. Time of Concentration:

The minimum time of concentration used shall be 5 minutes.

Time of Concentration shall be determined by the equation:

$$Tc = (0.0078 \text{ K L}^{0.77})/S^{0.3851}$$

Formula 5.2

Where:

Tc = Time of Concentration, minutes

Maximum length of Travel from most remote point in drainage basin to outlet, feet

S =

Average slope (feet/foot) = H/L Difference in elevation between most remote H = point and drainage outlet

K = 1.0 for natural basins with well defined channels, for overland flow on bare earth, and for mowed grass roadway channels.

2.0 for overland flow over grass surfaces K =

0.4 for overland flow, concrete or asphalt K = surfaces

0.2 for concrete channel K =

For areas with abrupt changes in topography or surface, the calculation shall be done for each segment and the total time of concentration shall be arrived at by adding the computed values for each segment.

4. Rainfall Intensity:

Rainfall intensity shall be obtained for specific design storm frequencies and times of concentration by using the Rainfall intensity-Duration-Frequency Curve for Boston, Massachusetts, as found in Technical Paper No. 25 of the U.S. Department of Commerce, Weather Bureau, December, 1966 on Rainfall Intensity-Duration-Frequency Curves.

¹This equation is based on a study by Z.P. Kirpich (1940)

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5. Coefficient of Runoff:

Values of runoff coefficient for use in the Rational equation (Q = CIA) shall be as defined in ASCE Manual No. 37, <u>Design and Construction of Sanitary and Storm Sewers</u> or Table 1 on Page 53 of <u>Design of Roadside Drainage Channels</u>, Hydraulic Design Series No. 4, U.S. Department of Commerce, Bureau of Public Roads, May, 1965.

b. <u>Ditches</u>

1. Geometric Requirements:

Ditches shall be of trapezoidal section, with a minimum depth of 18 inches and a minimum bottom width of 2 feet. They shall have a minimum gradient of 0.25% and a maximum design velocity of 2 feet/second for unlined channels. Water levels in ditches at design flow rates shall be at least 3 feet below the top of rail.

2. Flow Computation:

Drainage velocities and capacities shall be computed by use of Manning's Equation:

$$V = \frac{1.486}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Formula 5.3

where:

V = Velocity, ft/sec

n = Manning's Coefficient of Roughness

R = Hydraulic Radius, feet
= area/wetted perimeter

= area/welled perimete

S = Slope, feet/foot

Manning's "n" values shall be determined from ASCE Manual No. 37 or Table 2, Page 53-54 of <u>Design of Roadside Drainage Channels</u>, Hydraulic Design Series No. 4, U.S. Department of Commerce, Bureau of Public Roads, May, 1965.

3. Gutter Flows and Inlets

Where curbing is proposed along roadways, gutter flows and gutter inlets shall be designed in accordance with the U.S. DOT - Federal Highway Administration Hydraulic Engineering Circular No. 12, <u>Drainage of Highway Pavements</u>, March, 1984. At least 10' of the travel way shall be free of gutter flows.

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c. STORM DRAINS

1. Material, Cover and Structural Requirements:

Either reinforced concrete or asphalt-coated corrugated metal pipes shall be used. Minimum diameter pipe size shall be 12 inches. Culverts shall have a minimum diameter of 18 inches.

Pipes under railroad tracks shall be designed for Cooper E80 loading and shall have a minimum cover of 2 feet from bottom of tie to top of pipe.

Pipes under highways, parking lots and driveways shall be designed for H2O loading. They shall have a minimum cover of 1 foot from top of pavement to top of pipe.

2. Flow:

Manning's Equation, as defined in the ditch section and as shown below, shall be used.

$$Q = \frac{0.463D^{\frac{8}{3}}S^{\frac{1}{2}}}{n}$$
 Formula 5.4

Where:

full capacity

S = Pipe slope feet/foot)

Q = Flow (cubic feet per second)

 $n = Manning's roughness coefficient (Feet <math>^{1/6}$)

D = Pipe diameter (feet)

Pipes shall be designed for uniform flow, with a preferred velocity in the range of 3 to 9 feet per second. Maximum headwater for culverts shall be $1\!-\!1/2$ times the pipe diameter. At design flows, water shall not back up at the pipe entrance to an elevation higher than six inches below top of railroad subgrade or roadway pavement.

No pipe shall be designed with a size smaller than the next pipe upstream.

Manholes:

Manholes shall be installed at all pipe junctions and grade or alignment change points. Maximum pipe length between manholes shall be 300 feet.

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4. Catch Basins:

Catch basins shall be installed at all ground or pavement surface low points and all grades not drained by ditches or other means. The maximum interval between catch basins shall be 300 feet.

Catch basins shall have a 30 inch deep sump and a cast iron hood, frame and grate. Bicycle safe grates shall be used in station access roads, parking lots, and other areas where bicycle traffic is possible. Design of catch basins, cover and general arrangement must be done in a way to allow cleanout of sump with a clam shell bucket.

If leaching catch basins are used, they shall have a minimum of 12 inches of 2 inch diameter crushed stone placed around the outside. Their design shall be based on "perc" test data taken at the basin site. The design leaching capacity of the basin shall be increased to allow for partial blockage by debris and fine sediment.

d. <u>Perforated Pipe Drains</u>

Where ditches are not permitted by space, where additional flow capacity is needed, or where required to reduce underground hydrostatic pressure, perforated pipe drains shall be used. The pipes shall be perforated bituminous coated galvanized corrugated metal or perforated PVC. Minimum size shall be eight inch diameter in grade crossing installations and 12 inch diameter when used in place of ditches.

Where perforated pipes are used only as underdrains to reduce underground hydrostatic pressure and control groundwater elevation, the perforations shall face down. Where perforated pipes are being used to carry water with groundwater control a secondary requirement, the pipe shall be laid with perforations up. Use of perforated pipes to carry water shall be limited to the upper runs of a drainage system and checked to ascertain that they will not be subject to surcharging. Separate carrier pipes, for storm drainage shall be used in combination with perforated pipe underdrains in most cases.

Filters shall be used with all perforated pipe drains to prevent accumulation of sediment in the pipes. Filter material may consist of suitably graded crushed stone, synthetic filter material, or a combination thereof. The filter envelope shall extend a minimum of eight inches beyond the outside diameter of the pipe.

Perforated pipe drains shall discharge to a gravity drainage system or pump station. Care shall be taken to ensure that perforated pipe drains are not blocked by high water levels at

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the outlet. Relatively impervious materials such as loam or topsoil shall not be installed vertically above these pipe drains.

MHWA design gas traps or oil-water separators shall be provided in areas where runoff is subject to contamination with petroleum products and where required by regulatory authorities.

e. Recharge and Detention Ponds

1. Detention Ponds

Detention Ponds shall be designed when necessary to limit peak outflow from the design storm to an acceptable value. When these detention ponds discharge into a wetland a review by the local conservation commission is required. The detention ponds shall include provisions for removing sediment, if warranted. Each pond must be evaluated individually to determine if enough sediment will enter to justify a sedimentation basin.

Ponds shall be provided with an emergency overflow section to allow the safe discharge of water in excess of the design storm. Multiple outlets may be used when needed to accommodate maximum and minimum design storms. Required storage volume shall be determined using inflow and outflow hydrographs based on the Soil Conservation Service criteria or another approved method.

2. Recharge Basins

Recharge basins shall be designed with both a sedimentation basin section and a recharge basin section. The sedimentation basin shall be designed to remove all sediment that might plug the pores and reduce the basin's infiltration capacity.

The recharge basin section shall be designed to allow infiltration of the design storm within a reasonable period of time. The recharge basin capacity may be supplemented using recharge wells or trenches if necessary. The infiltration capacity shall be based on percolation field tests. Deep hole field tests shall be used to determine the depth to ground water and/or the location of impervious strata.

The combined storage capacity of the recharge and sedimentation basins shall be adequate to contain the runoff from the design storm. The basins shall have an emergency overflow to allow the safe discharge of water in excess of the design storm.

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f. Sedimentation and Erosion Control

1. Grading

Cut and fill slopes shall be as flat as practical. Minimum slopes shall be adequate to provide positive drainage. Mowed lawns shall have a 1% minimum slope and unmowed lawns or areas with groundcover shall have a minimum slope of 2%. Maximum mowable slopes shall not exceed 3:1 horizontal to vertical with an unmowable maximum slope of 2:1. Slopes steeper than 2:1 will require geotextile, rock or other protection treatments. The tops and toes of all slopes shall be rounded.

Roadways and parking areas shall be graded in accordance with the station and parking section of the Manual contained in Volume II.

2. Diversion Channels:

Diversion channels shall be located at the top of all steep cut slopes where terrain rises away from the track centerline. They shall be designed in accordance with the requirements of this chapter. Diversion channels shall discharge to the storm drainage system or a natural water course. Diversion channel outlets shall be designed to minimize erosion. All discharges into existing wetlands or within 100 feet of such shall comply with the rules and regulations of the local conservation commission.

3. Grade Stabilization Structure:

When it is necessary to convey storm water from one level to another across a steep slope, a grade stabilization structure shall be used. It may be a lined chute, drop box culvert, pipe drop inlet, channel with check dams, or other suitable structure.

4. Vegetation and Revegetation:

Grading operations shall minimize disturbance of existing vegetation. The design shall allow staged construction whenever practical to minimize the exposure of bare earth and the resulting sedimentation. Erosion control matting shall be used when necessary to avoid erosion of slopes before new vegetation can become established.

Vegetation requirements shall be coordinated by a landscape architect with the MBTA and each respective municipality.

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5. Local Requirements

Whenever work takes place in a wetland area or within the buffer zone, the local conservation commission must be contacted, a notice of intent filed if required, and any orders of conditions issued incorporated into the design. Conservation commissions typically will require control of sedimentation and erosion during construction. Appropriate measures such as silt fences, straw bale checks, staged construction, and revegetation requirements shall be incorporated into the design.

C. FENCING

1. General

Fencing is a critical element of the commuter rail physical plant. Fencing provides safety for the general public, protects passengers using our facilities and the operation of both the Authority's trains as well as the freight carriers. Fences perform various functions in a wide variety of locations. Selection of the proper size and type of fence as well as it's proper installation is important. No trespassing signs shall be attached to all gates and on fences, facing in both directions, at intervals not exceeding 200 feet and as detailed on Standard Plans.

2. Types of Fences

Reference Standard Plans - No. 3200, 3204, 3206 and 3208.

The primary fence type is chain link at heights of 48 inch, 72 inch, 96 inch and 120 inch. The three strand barbed wire top is an option on all chain link fence.

High Security Fence consists of a very dense, close-spaced, difficult to climb mesh fabric with closer post spacing.

At overhead bridges, special mounting details are required. Also, special fence details using posts and fabric that curve back over the bridge to prevent throwing objects, (anti-missile fencing) at trains may be necessary at high risk locations.

Gates may be single swing, double swing or sliding as appropriate for the location, size of opening and use. In all cases, the design of the gate and related hardware must be of the heaviest, most durable material available to provide reliable operation over the life of the installation.

Snow fences are usually a portable type installed seasonally by maintenance forces. Treated timber fences of permanent construction may be used for this purpose and/or as a view block in areas where snow

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drifting is a regular problem and where a visually solid fence would not be objectional.

3. Uses of Fences

a. Right-of-Way Fence

Fencing along the Authority's right-of-way is used to prevent unauthorized entry as well as to define the property of the Authority and abutters. The size and exact type of fence to use at a specific location is a function of the existing and potential degree of trespassing at that location. The following is a general guideline arranged in ascending order of control of trespassing:

4	Very rural-wooded	No fence
•	Rural-fields or farmland	72" CLF
٠	Light Suburban	72" CLF
	Medium to Dense Suburban	72" CLF with B/W
	Urban	96" CLF with B/W
•	Urban areas with severe	
	trespassing problems	96" HS-CLF with B/W

B/W = Barbed wire top-3 strands HS = High Security Type fence

Gates must be located at suitable sites and frequency to allow maintenance personnel access to the right-of-way. This is especially critical at interlockings.

At a specific location, where trespassing has been a problem, a short segment of a more restrictive fence may be installed than used in the balance of the installation.

b. On-Site Access Control

Fences may be used at stations and parking areas to control where and how people move about. This is generally for their safety but may also be a means of directing them to the areas intended. In most situations, 48 inch CLF is appropriate for this purpose. Intertrack Fence is a particular use of this type of fence and is detailed on Standard Plan No. 3204. Its installation details and lack of a top rail is unique to that use. (See Station Design Section of Manual also.)

c. Snow Fences

Reference Standard Plan - 3200

Drifting snow caused by prevailing winds from the direction of open areas and accumulation of snow in cuts can be a problem for maintenance forces and have adverse affects on train operations,

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station platforms, parking areas and access roads. Installation of snow fences is usually seasonal using portable type fences. In certain instances, it may be appropriate to use a permanent fence such as the "Wood Open Board Fence" shown on Standard Plan 3200. Landscape plantings of evergreens may also be effective barriers to use on a permanent basis where fences may be inappropriate.

d. Overhead Bridges

Overhead bridges, both vehicular and pedestrian, pose problems related to debris being thrown and dropped on the right-of-way and trains. Anti-missile fencing may be used as a barrier in these locations with special curved posts and extra wide fabric utilized at locations where vandalism is prevalent. Fan guards or short cantilever fence sections may be helpful at the ends of fence on bridge approaches.

e. Fence Setback from Property Lines

In most cases, right-of-way fences shall be installed 12 inches from the actual property or ROW line and on Authority property. Where clearances are close and where directed, this dimension may be reduced to 6 inches.

D. RIGHT-OF-WAY SIGNS, POSTS AND MARKERS

Reference Standard Plans 3300 to 3399

1. General

Various signs, both informational and regulatory, are required around any railroad. During reconstruction or new installation of right-of-way facilities, replacement, reinstallation and furnishing new signs shall be considered an integral part of the project. Specific signs related to stations and parking facilities are <u>not</u> covered in this section. These signs are covered in Section II, Stations and Parking.

Right-of-Way signs generally fall into two categories - informational and regulatory. Informational signs include:

- . Mileposts
- . Close Clearance Warnings
- . Yard Limits
- . Flanger Warning Boards

Regulatory signs include:

- . Speed Boards Permanent and Temporary
- . Whistle Posts

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- 2. Lettering shall be Helvetica Medium with certain applications in condensed form. Exceptions to the above only with direction from the Chief Engineering Officer. Letters shall be black gloss silk screen conforming to Mass Highway Department (MHD) material spec. M7.04.12 or reflectorized press-on vinyl equal to black "Scotchal".
- 3. Background shall be reflectorized white paint meeting Federal Specification FSL-S-300 A type, Class 1 or 2, reflectivity 1 for mileposts and no trespassing signs.

Other signs with colored background shall use an adhesive vinyl covering as follows:

- . Yellow No. 2271 Yellow Scotchlite
- . Green No. 2277 Green Scotchlite
- . Silver No. 2870 Silver Scotchlite
- 4. Sign boards shall be made from 0.081 inch thick aluminum alloy 6061-T6. Mile posts shall have a 1/4 inch thick steel sign back behind each sign panel as per Standard Plan 3302. Other permanent signs shall also include a 1/4 inch thick steel sign back when scrap rail sections are used as a post. Steel board to be welded to base of rail along both edges.

Aluminum sign boards shall be mounted to steel sign back with a minimum of four 5/16 inch \times 1 inch bolts with lock nuts and washers, all cadmium plated.

Steel sign backs shall be cleaned with a grease cutting solvent, primed and painted with two coats of white enamel prior to mounting sign boards.

5. Sign posts for free standing, permanent signs are preferred to be fabricated from used rail sections at least 112 lb section, free from bends, kinks or visible damage. Rails shall be cleaned with a grease cutting solvent, primed and painted with two coats of white enamel after welding on steel sign boards.

Temporary signs or small (18 inch \times 24 inch or less) signs may use steel "U" posts or square posts pre-drilled for mounting. Posts shall have 1/4 inch thick anchor plates attached per detail on Standard Plan 3306.

Any sign post which could be struck by a motor vehicle shall include a break-away mounting.

- 6. Sign locations
 - a. General The designer shall coordinate required signage and location with Railroad Operations. In general, the following signs and markers are required.

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- b. Mileposts Are located based on mileage from the primary terminal (North or South Station) and are located to the right of the outbound track with the mileage signs facing in both directions. Miles should be based on the original railroad stationing whenever possible.
 - If the existing mileposts are made of granite and are in good condition, they may be repainted (white) on top and lettering redone (black) and reused instead of the rail post mile marker.
- c. Permanent speed boards shall be placed at every point where there is a change in the authorized speed and at least every two miles.
- d. Yard limit signs shall be placed at yard limits facing both inward and outward tracks at locations where there are defined yard limits. Yard limit locations should be checked with Railroad Operations. Yard limits are normally defined by the carrier operating freight service, not by the Authority.
- e. Whistle posts shall be located 1000 feet in advance of location for which locomotive whistle is to be sounded.
- f. Ring post shall be at location where locomotive bell ringing is to commence and repeated every 1000 feet where prolonged ringing is required.
- g. Crossing circuit sign shall be placed at start of grade crossing protection circuit. On bi-directional tracks (signalled for movement in either direction), signs shall be provided on both approaches to the crossing. When crossings are close together and the crossing circuits overlap, signs shall also include small letters to indicate the crossing number (in mileage from terminal) of the respective crossing. Signs shall be placed directly opposite the insulated joints concerned.
- h. Stop posts shall be used to indicate a grade crossing for which no protection is provided or for a crossing where a full stop must be made before activating the protection. Sign shall be placed 25 feet in advance of the crossing or opposite the insulated joint.

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CHAPTER 6
CLEARANCE CRITERIA

Reference Standard Plans - 1012 to 1019

A. General

Providing and maintaining adequate horizontal and vertical clearance is a key element in the safe operation of a railroad. Existing clearances on many routes in the Authority's territory are sub-standard by today's requirements due to the age of the facilities. During reconstruction and renewal, improvements in clearance that can be achieved are a priority item.

To the extent possible, new facilities or major rehabilitation and reconstruction shall conform to current Commonwealth of Massachusetts Statutes for clearance within yard limits. These statutes require a 22'-6" vertical clearance above top of rail, 8'-6" to any side obstruction from centerline of track and 13'-0" track centers with suitable increases for curvature. Various exceptions to the above are noted on the referenced standard plans and discussed in more detail below.

B. Vertical Clearances

1. Background

Vertical clearance within yard limits is defined by state statute as 22'-6" above top of rail. Yard limits were or are defined by the freight carriers, not by the MBTA. Historically, the requirement for 22'-6" clearance is based on protecting personnel walking on top of a box car that typically was about 15'-6" high. This is now a prohibited practice, roof walks are no longer placed on cars and brake wheels have been moved from the top of cars to a height just above the coupler.

Today, freight carriers are very concerned with improving clearances so they can remain competitive and handle cars which are considerably taller than the 14' to 15-1/2' box car of previous times. Fully enclosed tri-level automobile carriers and double-stack containers (shipping containers stacked two high on special drop-well flat cars) require a clearance just under 21 feet.

The MBTA has an interest in providing sufficient clearance for future electrification. This will be practical if the 22'-6" dimension is used and would be possible for passenger operation and very limited freight operation with 18'-0" clearance.

Minimum Vertical Clearance

When and if 22'-6" is not possible, lesser clearance will be permissible. Standard Plan 1016 gives the minimum vertical clearance by route segment which will satisfy both the MBTA's and current freight carrier's requirements. These clearances are subject to frequent revision due to changing requirements of freight carriers. Designers must check with railroad operations before design is advanced.

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The absolute minimum clearance that is required to clear equipment of the MBTA and allow for dynamic movement plus a nominal safety factor and minimal resurfacing raise is 16'-4". Any clearances between 16'-4" and those indicated on Standard Plan 1016 must be approved by the Chief Engineering Officer.

3. Compensation for Superelevation

If tracks are superelevated under an overhead structure, clearance must be increased to allow the required vertical clearance out to a point 7'-0" from centerline of track on a plane even with the top of rail of superelevated track. (See sketch on Standard Plan 1016).

Relative to the low rail, which is the profile grade line, the required increase is defined by the following formula:

Increased clearance in inches = $1.43 \times Ea$

Formula 6.1

Where:

Ea = Actual Superelevation in Inches

4. Compensation for Vertical Curves

When there are vertical curves at overhead obstructions, allowance must be made for the vertical mid-ordinate of a car up to 90 feet long.

Increased clearance =
$$\frac{0.90 \times G_1 - G_2}{8}$$

Formula 6.2

Where:

 G_1 = Grade at PVC in percent G_2 = Grade at PVT in percent

C. Horizontal Clearances

1. Background

By state statute, horizontal clearance within yard limits is 8'-6" from centerline of track from a plane at the top of rail vertically upward to the vertical clearance restriction. Yard limits were or are defined by the freight carriers, not the MBTA. The reason for 8'-6" is to allow a brakeman riding the side of a car to clear any obstructions. 8'-6" also provides room for a train to clear someone standing along side. The exception to the above is switch stands and other individual obstructions necessary for the operation of the railroad which are less than 3'-0" above top of rail. The reasoning being that a man riding the side of a car will be over that height and because they are only

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point obstructions, a pedestrian would not get trapped between it and a train.

Although 8'-6" side clearance is dictated only within yard limits, it is imperative that this clearance be maintained everywhere possible for safety. Where 8'-6" side clearance cannot be maintained, safety niches must be provided and warning signs posted. (See Part E following).

2. Allowable Exceptions to 8'-6" Side Clearance.

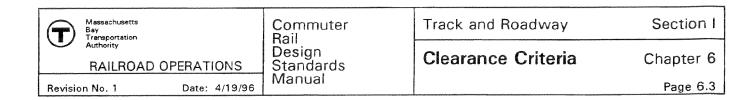
Due to operational and physical requirements, certain elements, under certain conditions may intrude into the 8'-6" tangent clearance envelope as follows:

- a. Low switch stands and electric locks less than 3'-0" above top of rail may be 6'-6" from centerline.
- b. Low passenger platforms (less than 8" above top of rail) may be 5'-1" from centerline.
- c. High passenger platforms (4'-0" above top of rail) may be 5'-7" from centerline. On certain routes, a breakaway, foldup edge to allow 7'-3" for over-dimension freight movements shall be provided. (See Article 5, following). At major terminals with direct fixation track and no freight operation, 5'-4" may be used.
- d. Intertrack fence at passenger stations may be 6'-0" from track centerline if fence is not more than 4'-0" high. (See Standard Plan 3204).
- e. Top flange of through plate girder bridges less than 4'-0" above top of rail may be closer than 8'-6" as shown on Standard Plan 1017 and with the conditions indicated in the asterisk note (*) on that plan.
- f. Dwarf signals outside of track to be 7'-6" from centerline. Dwarf signals between multiple tracks permitted only if not over 2'-0" above top of rail.
- g. Platform canopies may be 7'-6" from centerline of track except on Framingham/Worcester Line, maintain 8'-6".
- 3. Side Clearance Increase for Superelevation

All side clearances must be increased on the inside or low side of curves to compensate for the inward lean of equipment. The formula used for this purpose is:

Increased side clearance in inches = h/5 x Ea

Formula 6.3



Where:

h = Height of obstruction above top of rail in feet.

Ea = Actual superelevation in inches.

4. Side Clearance Increase for Curvature

Side clearances must be increased for curvature on both the inside and outside of curves. This is to maintain equivalent tangent clearance which would otherwise be decreased due to end overhang of the car on the outside of curves and mid-ordinate swing-in on the inside of curves.

Side clearance increase, both inside and outside of curves, shall be 1 inch per degree of curvature. Exception - at passenger platforms, on the outside or high side of curves, side clearance shall be increased only one half inch per degree. At platforms, clearances for curvature in excess of two degrees and in excess of one inch actual superelevation shall be reviewed by the Chief Engineering officer. (See Standard Plan 1019).

5. Special Side Clearance at High Platforms for Freight Operations

On certain routes shared by through freight operations, the 5'-7" side clearance to high platforms is not always sufficient for all types of freight equipment under all operating conditions. Provision must be made for providing 7'-3" side clearance on an occassional basis by swinging the platform edges up and locking in a vertical position. This will allow passage of over-dimension equipment. In addition, the outer 9 inches of the platform must be made of a material that will shatter and the supports swing out of the way when accidently struck.

Special details for this type of platform edge have been previously developed and are available from Railroad Operations.

All high level platforms in territory where through freight service operates shall have the collapsible edge. The fold-up edge or other means such as a gauntlet track to allow 7'-3" side clearance, must be provided on the following routes or segments thereof.

NORTHSIDE

West Route - Wilmington Junction to State line New Hampshire Main Line - Boston to State Line Wildcat - Wilmington to Wilmington Junction Fitchburg Main line - Willows to Fitchburg

SOUTHSIDE

Framingham (B&A) Main Line - Beacon Park to Worcester Middleboro Secondary - Braintree to Middleboro Franklin Branch - Walpole to Readville

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6. Side Clearance - Special Issues

The designer should always be diligent in looking for and checking points that have or will have substandard side clearance. Even on tangents adjacent to curves, it should be remembered that car overhang resulting from curvature extends the full length of the car into the tangent.

High platforms pose especially critical clearance concerns, particularly when curvature is involved and freight operations use the track. All elements affecting clearance including curvature, superelevation, vehicle outlines and dynamic movement must be considered.

D. Track Centers

1. Standard Track Center Dimension

The standard track centers for tangent main line track effective the date of issue of this standard is 14'-0". Track centers of 13'-0" are permissable on an interim basis at such locations where 14'-0" is currently not possible.

The standard track centers for tangent main line track to an adjacent track used as a yard or switching lead, where personnel may be standing or walking in the space between the tracks, is 17'-0".

2. Track Center Increase for Curvature

Track centers must be increased at the rate of 2 inches per degree of curvature to allow for both end overhang and mid ordinate swing-in on adjacent, concentric tracks. It is essential that equivalent tangent track centers be maintained on curves. The equivalent tangent track center is the nominal tangent track center for the route segment. When re-designing curves, strive to provide equivalent 14'-0" tangent tracks centers wherever possible, but in no case less than 13'-0".

3. Absolute Minimum Track Centers

No commuter rail operations will be permitted on track centers less than 11'-8" on tangent. Track centers must be increased above 11'-8" for curvature and check that adjacent tracks have the same superelevation. No new construction will be allowed at 11'-8" track centers except temporary layouts during phased construction when absolutely necessary.

4. Track Center Increase For Unequal Superelevation

When the outer track has more actual superelevation than the inner track, increase the track center dimension 3 1/2 inches per inch of superelevation difference. This is in addition to the 2 inches per degree for curvature.

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5. Concentric Curves in Multiple Track

In curved multiple track, the tracks shall be concentric unless the curve is being used to spread tracks for a center platform, bridge pier, etc. Track centers providing less than 14'-0" equivalent tangent clearance shall be spread at 2 inches per degree on the curve. Transition back to standard tangent centers within the spirals by increasing the length of spirals on the inside track to a length such that the spiral offset (p) is increased over that of the outside track spiral by an amount equal to the track center increase.

E. Safety Niches

1. Where Required

Safety niches shall be provided at all locations where side clearances from center line of track on both sides of the track bed are less than 8'-6" over a total distance along the track in excess of 100 feet.

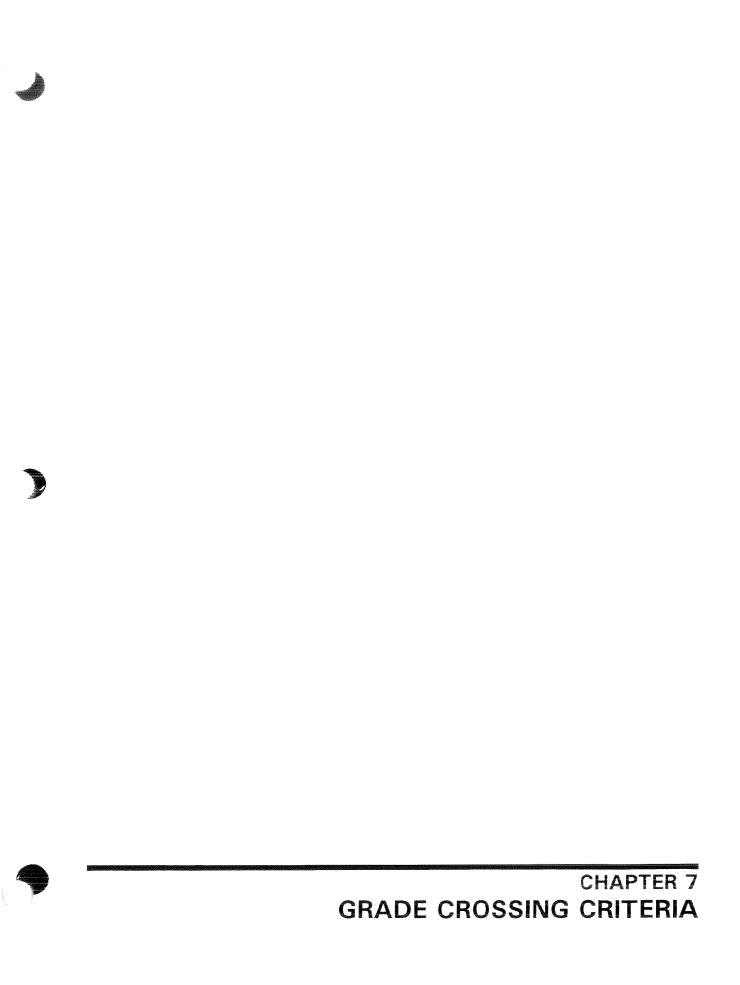
2. Dimensional Requirement

Safety niches shall be no less than 7'-0" high by 2'-0" wide. The base or floor of the niche shall be not more than 8 inches above top of rail or in no case higher above adjacent finihsed grade than 18 inches. Backwall of niche shall be at least 8'-6" from centerline of track and niches shall not be less than 1'-0" deep.

3. Placement Interval

Where niches are required, they shall be spaced every 25'-0" on center and when on both sides of the trackbed they shall be staggered from those on the opposite side of track by 12'-6".

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Reference Standard Plans 3100, 3106, 3108, 3120

A. General

Vehicular grade crossings pose acute problems from both a safety and maintenance perspective. As stated in Design Objectives/Guidelines, Chapter 2, no new grade crossings, either public or private, will be permitted except with approval of various agencies and then only when no other reasonable alternative is available.

By their very nature, grade crossings are a potential hazard to all who use them, both in trains, motor vehicles and pedestrians. Elimination of grade crossings whenever possible is a first order priority on any project. In addition to new grade separation structures, crossings may also be eliminated by combining multiple crossings and diverting vehicular traffic onto a nearby grade separation.

There are many elements to consider in designing or improving a crossing. These include road profile, vehicular sight distances, type, number and placement of warning devices, traffic turning movements, traffic volume, percent of truck traffic, pedestrian travel paths, railroad sight distance, railroad operating speed, track geometry and superelevation as it would affect road profile and traffic signal pre-emption if their are signalized intersections in the immediate area. These elements all affect the safety of a crossing, which is the primary concern.

Maintenance of a crossing is also a major concern. The track structure at a grade crossing experiences increased deterioration due to wet conditions, sand and salt infiltration from road surfaces, loadings from highway traffic, all exacerbated by the fact that the track structure is encapsulated by the crossing surface, making track maintenance difficult and costly. It is essential that crossings be constructed to high standards and that crossing surface material can be removed and replaced in an expedient manner.

B. Types of Crossing Surfaces/Usages

Permanent mainline track crossings shall use full depth rubber when the Average Daily Traffic Volume (ADT) for the roadway exceeds 2500 or if more than 100 trucks per day use the crossing.

Permanent crossings with lesser volumes may use the rubber rail seal and bituminous type crossing.

Temporary construction type crossings and very low volume private crossings - as determined by the Chief Engineering Officer - shall use the pressure treated timber type crossing surface.

The full depth rubber crossing shall be of a design which allows installation without bolting or lagging from the top surface into the ties and must be designed to allow installation over the standard resilient fasteners.

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C. Design Criteria

1. Highway Design

a. Horizontal Geometry

The geometric design criteria for the highway approach to a grade crossing must maximize sight distance to the crossing and remove any hazards and visual distractions to the driver. Curved approaches to the crossing are undesirable. Intersections at or near the crossing are extremely undesirable. Driveways or any entrance to the roadway within 75 to 100 feet of the crossing are undesirable. Changes in pavement width or number of lanes near the crossing are undesirable. Crossing angles less than 60 degrees are undesirable.

b. Vertical Geometry

Sight distances must be maximized by removing or flattening any vertical curves which limit the stopping sight distance to values less than the predominant traffic speed on the road. Very sharp vertical curves in the vicinity of the crossing are prohibited.

c. Pavement Design

Permanent pavement shall be hot mix asphalt applied in not less than two lifts consisting of a 5 inch base course and a 3 inch top course. New pavement shall extend not less than 9'-0" from edge of crossing surface. Existing pavement shall be saw cut to produce a clean, uniform pavement edge. Pavement specifications shall conform with MBTA Standard Specification, Section 02513 - Bituminous Concrete Pavement, for Base Course and Top Course.

The pavement subgrade in the approach to crossings should be disturbed as little as possible. Where conduits, underdrains and storm drains are installed, the width of trench should be kept to a minimum and gravel backfill placed and compacted in lifts not more than 6 inches each.

2. Railroad Design

a. Geometry

Curvature through a grade crossing is undesirable. When curvature is necessary, track superelevation should be limited to 2 inches to minimize the abrupt grade changes that occur to the road surface in multiple track crossings from one track to the other. If additional superelevation is mandated, the profile of the outer track should be adjusted upward at the crossing to provide a uniform cross slope across both tracks. This type of profile adjustment is undesirable and increasing superelevation in the crossing in excess of 2 inches will not be permitted

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without the approval of the Chief Engineering Officer.

Low points in the railroad profile at grade crossings should be avoided as this will exacerbate the retention of water in the subgrade at the crossing.

b. Subgrade

Maintenance of a firm, dry subgrade is essential to the satisfactory performance of a grade crossing. When a crossing is to be rebuilt, the nature and condition of the subgrade should be determined. The maintenance history of the crossing should be obtained from interviews with maintenance personnel and visual observations made to note poor track surface, fouled ballast, excess moisture and other indications of subgrade problems.

Tf problems suspected. subsurface subgrade are investigations must be undertaken to determine depth, extent and nature of the poor subgrade material. A program of subgrade modification/remediation must be prepared to allow construction of a crossing that will maintain track and roadway surface. The 5 inch hot mix asphalt underlayment, which is standard at all grade crossings, provides a good separation layer and load However, it should only be placed on distribution medium. granular material which will allow movement of moisture laterally The depth of excavation required below the to underdrains. bottom of the asphalt and replacement with granular material should be determined by the designer. In general, subgrade remediation measures beneath the asphalt layer should be initiated when the subgrade resilient modulus (Es) is less than 7500 psi or the California Bearing Ratio is less than 5.0.

The hot mix asphalt layer must be a low modulus mix with 1-3 percent air voids, (compacted), a high asphalt cement content and a high mineral-aggregate fines component. The job mix formula recommended for the hot mix asphalt is stated in Chapter 6, Section A.4.

c. Track Structure

The track structure on top of the HMA underlayment shall consist of 12 inches of crushed stone ballast (measured from bottom of tie), 7 inch x 9 inch treated timber ties 9'-0" long at 18 inch spacing through the actual crossing surface limits plus 3 ties beyond on each end and 8 foot 6 inch long ties at 19½ inch spacing to the limits of the HMA. (See Standard Plan No. 3100). In concrete tie territory, standard concrete ties may be used, however spacing and design of crossing panels must be coordinated. Rail through the crossing shall be 132 RE section continuous welded rail. Joints will not be permitted in the crossing or within 50 feet either side of the crossing surface except bonded insulated joint plug rails beyond the crossing

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surface as required for crossing circuits. Transition tie section shall be placed in advance of HMA underlayment per Standard Plan No. 1108. Standard resilient fasteners and plates will be used throughout. No tie pads shall be used in the crossing when timber ties are used.

3. Conduits - Signal & Communication

a. General Requirements

Standard Plan No. 3100 indicates the minimum number and general arrangement of 4 inch Galvanized Rigid Steel (GRS) conduits required at each crossing installation. These conduits are necessary for the automatic highway crossing protection, the signal system, communication system and provision for future expansion – in most instances. At certain locations, additional conduits may be required as directed by Railroad Operations. It is essential that the ends of conduits be plugged and located by the installer by preparing an $8\,\%$ " x 11" minimum sketch with swing ties to existing physical features and then a witness stake placed over the ends after backfilling. In addition, conduits which do not have cable in place shall have a pull wire installed.

Where there are fibre optics installations, the owning company(s) must be contacted during design. Measures to protect their facilities or schedule and coordinate the fiber optics company's relocation or modification must be incorporated into the contract documents.

b. Location

The general location of required conduits is defined on Standard Plan 3100. This plan is generic in nature and individual crossings may require some modifications and additions. The lateral conduits must be installed under the HMA underlayment. The side of the right-of-way to receive the 9-4 inch conduits versus the 4-4 inch conduits is a function of the location of the primary signal cables and equipment case for the crossing protection.

The location of the conduits must be coordinated to avoid interference with underdrains and storm drains or other existing and proposed utilities.

Trenching for conduits must be kept to the minimum width possible and backfill placed around the conduits must be free of rocks or other sharp, hard material.

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D. Drainage Considerations

1. General

Removal of surface water and effective reduction of pore water pressure in the subgrade are important measures for providing a crossing which will maintain smooth rail and highway surface with minimal maintenance. Measures which will accomplish these are well known, commonly used in general site work and include perforated pipe underdrains in combination with french drains (ballast filled trenches).

2. Avoid Low Points At Crossings

Highway profiles which have a low point in the crossing are very undesirable. To the extent possible, highway profiles and grading should be set to form a low point or swale off the crossing area parallel to the track on either side of the crossing. This will intercept the surface runoff from the road before reaching the crossing. This water can be directed into a closed drainage system, where available, or directed into adjacent Right-Of-Way (ROW) ditches if they are available.

3. Underdrains

Perforated pipe underdrains set in ballast filled trenches on either side of the HMA underlayment (see Standard Plan 3106) and protected from clogging with filter fabric are an effective means of removing water from the crossing area and lowering pore water pressure. However, they are fully effective only when the underdrains can outlet to some lower point. ROW ditches are the primary choice for this purpose, if present, and if water levels are normally not so high as to prevent flow from the underdrains.

Existing storm water drainage systems, if present, can provide a positive discharge point. Permission from the local department of public works is necessary and the capacity and hydraulics of the system should be investigated to determine if it surcharges on a regular basis.

Piping to a nearby natural low point away from the right-of-way is another option. If wetlands or watercourses are the ultimate discharge point, an order of conditions and other requirements may be imposed by the local conservation commission.

Piping to a drywell, removed from the immediate area of the crossing, is a possible solution when no other option is available. This would typically not be effective during periods of high rainfall but provide for removal of water from the crossing at other times.

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4. Storm Drains

Separate storm drains must be used to carry surface water runoff through the crossing area where right-of-way ditches are present. Use of perforated pipe underdrains for this purpose is prohibited.

Where there are existing municipal storm drains passing through the crossing, their condition and type of material should be determined prior to crossing reconstruction. If they are in poor condition, consideration may be given to replacement during crossing reconstruction.

E. Existing Utilities

The designer should determine the presence and condition of all utilities in the crossing area and coordinate protection and possible replacement with the responsible utility or municipality during crossing reconstruction.

F. Plan Preparation/Design Requirements

1. General Requirements

When grade crossings are to be reconstructed, the designer shall provide an overall site plan detailing existing and proposed physical features and location of all existing and proposed signal equipment and cases. The plan should include, or be supplemented by an additional plan, delineating existing utilities above and below ground and show the proposed location of new ducts, cables, drainage and pole lines. Road profiles must be provided, and if trackwork is being done, profiles of the railroad and amount of superelevation at the crossing. Limits of pavement renewal shall be defined on the plans and road profiles.

2. Design

In addition to elements noted in this chapter, the designer must determine placement of equipment cases, crossing gates and all other proposed construction, considering sight distance, clearances, maintenance access and interference with existing facilities. Placement of new equipment must be fully defined on the plans. If crib walls, embankment or cut widening, or ditch relocation is required for placement or support of new equipment, these elements must be delineated and detailed on the plans.

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RAILROAD OPERATIONS

COMMUTER RAIL DESIGN STANDARDS MANUAL

VOLUME I SECTION II

STATIONS AND PARKING

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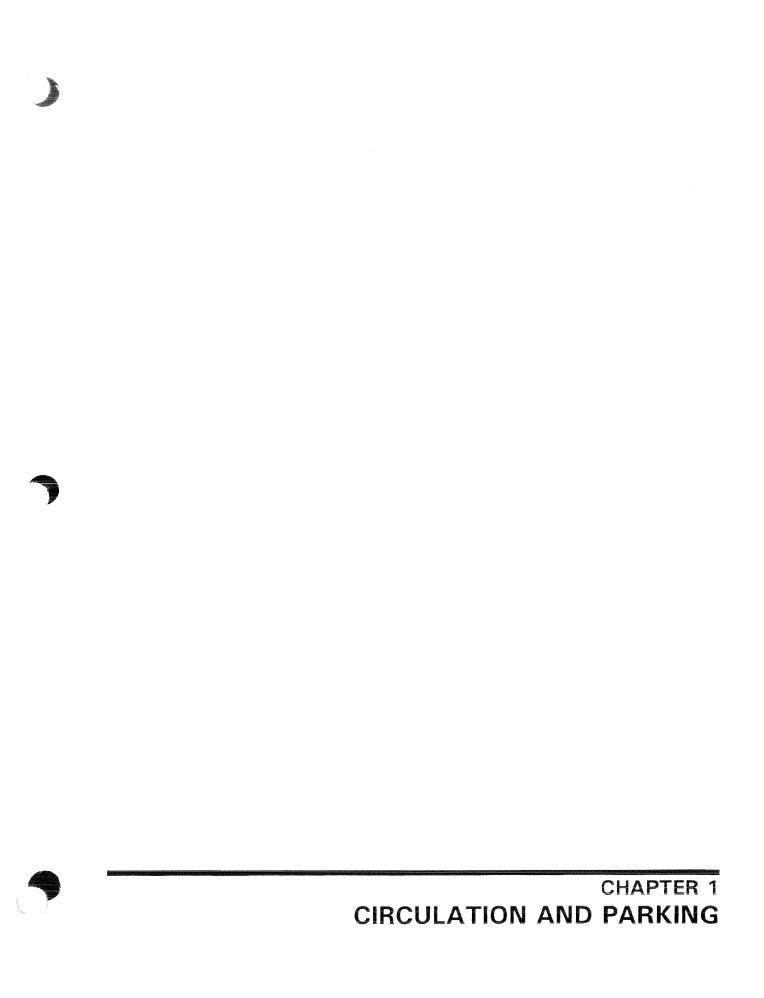
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I. INTRODUCTION

Design standards for vehicular and pedestrian circulation and parking facilities at commuter rail stations are addressed in this section. The guidelines contained herein are intended to direct design consultants in the development of plans and details that will conform to the Authority's current goals for commuter rail station design. These guidelines include design criteria for roadways, walkways, stairs, ramps, and parking lots. Current State and Federal rules, regulations and standards for accessibility are applicable to commuter rail station facilities. (Refer also to the MBTA Guide to Access).

It should be emphasized that these standards are not exhaustive and will leave many site specific issues unaddressed. It is the design consultant's responsibility to seek direction from the Authority where situations arise not covered by these guidelines. Further, it is the responsibility of the design consultant to review the latest applicable Federal, State, and local regulations. Where conflict may exist between such regulations, these guidelines, and/or the MBTA Guide to Access, the most stringent shall apply.

II. DESIGN OBJECTIVES

Safety, efficiency, and accessibility are the principal objectives to consider in the design of circulation and parking facilities at commuter stations. The organization and detail of the station design must also address specific issues of security, maintenance, and snow removal.

III. DESIGN GUIDELINES

A. Separation of Circulation Modes

For the maximization of safety station site circulation modes of pedestrian, vehicular, and rail movements should be separately delineated. Locations where circulation modes cross or interface must be well identified and sight lines maximized.

B. Arrival/Departure Modes

Station design must address the variety of arrival/departure modes:

- Pedestrian walk-in and bicycles
- Public transportation, including taxis
- Drop-off/pick-up
- Park and ride

Pedestrian, public transportation, and drop-off/pick-up modes should be encouraged by minimizing walking distances from site entry points, and curbside stops to the platform.

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C. Pedestrian Circulation

- 1. General Principles
 - a. Pedestrian pathways should be direct, well defined, and provide a clear indication of where they lead.
 - b. Pedestrian access from the surrounding community should be encouraged by providing a direct, paved walkway to the platforms.
 - c. An accessible route of travel, free from steps, must link the accessible station entrance with public sidewalks, bus stops, parking and passenger loading zones. The platform may be considered to be a part of this accessible entrance route. With exceptions allowing for specific site conditions, this accessible route of travel should be the primary route for all station users.

2. Walkways

Note:

The following section represents a partial summary of the design constraints for walkways. Consult the MBTA $\underline{\text{Guide to Access}}$ and relevant codes for additional information.

a. Width: 5'-0" preferred minimum 4'-0" absolute minimum

Notes:

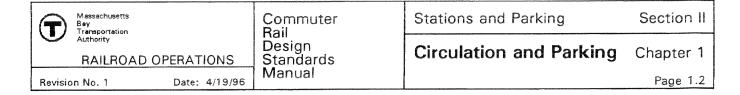
- 1. For widths less than 5'-0", provide 5'-0" by 5'-0" passing spaces at intervals not to exceed 200'-0".
- 2. Subject to Authority approval and code compliance, the clear width of an accessible route may be a minimum of 36" excluding curb stones and 32" at columns or other obstructions having a depth less than 24".
- b. Slope in the 5% (approx. 5/8" per foot) direction of travel: absolute maximum

Note:

If the slope is greater than 5%, it must be treated as a ramp with a maximum slope of 8%.

Cross-slope: 2% maximum

- c. No level change greater than 1/2" is permitted unless a ramp is provided. Level changes between 1/4" and 1/2" must be beveled with a maximum slope of 1:2.
- d. Walkway surfaces must be slip-resistant (minimum static coefficient of friction of 0.6) with all joints finished flush.



e. Walkways adjacent to roadways should be physically separated by curbing, guardrail, or bollards for safety and to prevent encroachment by vehicles.

Note:

The use of bollards should be minimized as they may interfere with snow removal.

- f. Where sidewalks are located immediately adjacent to parking areas, vehicle overhang from 90° or angle parking should be accounted for in the layout of walkways to ensure that required sidewalk width is maintained.
- g. Snow removal and storage must be considered in the location and design of sidewalks.
- h. Sidewalk shall not be utilized simply as a design element, such as an edge treatment along a roadway. Minimize the amount of sidewalk to that which is truly required.

Crosswalks

- a. Locate crosswalks to maximize visibility between pedestrians and vehicles.
- b. Width: Equal to or wider than walkway width.
 (6'-0" minimum)
 Curb cuts at marked crossings must be wholly within the crossing markings (excluding flared sides).
- c. Pedestrian roadway crossings should be defined by white warning stripes painted on the surface of the roadway (See diagram following).
- d. Curb cuts must be provided wherever an accessible route crosses a curb. The preferred minimum width of curb cuts shall be 40" (absolute minimum no less than 36"), not including sloped sides. The maximum slope of the curb ramp shall be 1:12.
- e. Curb cut ramps must be installed perpendicular to the curbs.

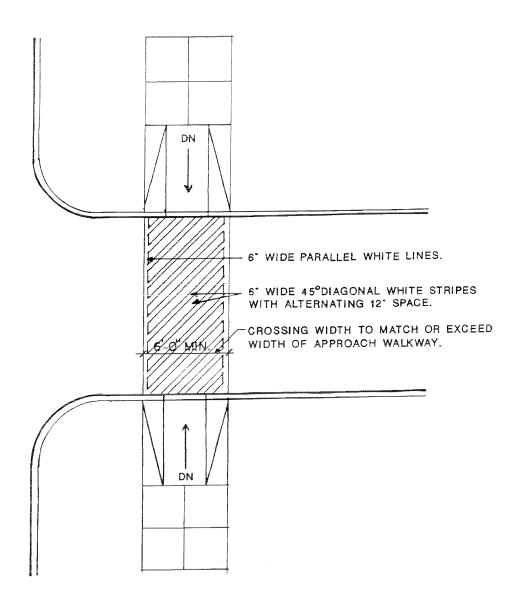
 Diagonal curb cuts are not allowed.

Note:

Consult the MBTA Guide to Access for additional information on the location and design of curb cuts.

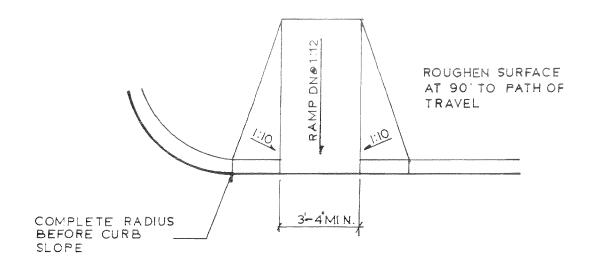
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Typical Marking of Pedestrian Roadway Crossing

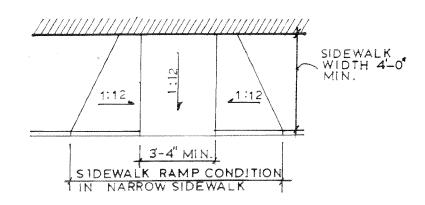


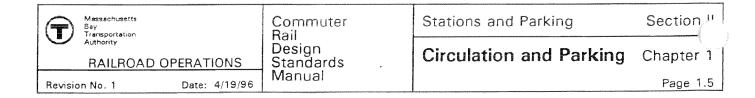
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Typical Curb Cut



Curb Cut in Narrow Sidewalk





4. Ramps

Note:

The following section represents a partial summary of the design requirements for ramps. Consult the MBTA Guide to Access and applicable Federal and State codes for additional information.

a. Width:

4'-0" absolute minimum

(measured from inside to inside of railing)

b. Slope:

8% maximum

(1" rise in 12.5" run)

Note:

Ramps shall have a cross slope that is 1:50 (2%) or less.

c. Distance between landings:

30'-0" maximum

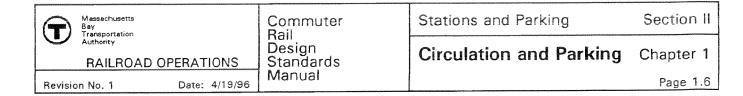
d. Length of Landings:

Equal to width of ramp (5'-0" minimum length)

Note:

Where a ramp changes direction the landing should be at least 5'-0" by 5'-0". Adequate drainage must be provided to prevent ponding of water at landings.

- e. Provide a level area that is 5'-0" in length and equal to the width of the ramp (2% maximum slope in either direction) at the top and bottom of each ramp.
- f. Ramps shall have a slip-resistant (minimum static coefficient of friction of 0.8) and a glare-free surface.
- g. Run-off is the clear area between the end of a stair or ramp and the nearest obstruction conflicting with pedestrian movement.
 - (1) The run-off to an obstruction such as a wall, kiosk, or pier should be equal to 1.7 times the width of the ramp.
 - (2) The run-off to the edge of a queuing space, such as the front edge of a platform, should be at least 10'-0".
- h. Ramps and landings with drop-offs shall have curbs, walls, railings or projecting surfaces that prevent people and wheel chairs from slipping off the ramp. Curbs shall be a minimum of 2" high. Protective railings shall allow a maximum 2" vertical gap above the ramp surface. Projecting surfaces must extend a minimum of 12" beyond the outside of the guard/hand rail.
- i. Handrails at ramps:
 - (1) Provide continuous handrails on both sides of all ramps.



2'-10" and 1'-7" Heights: (2)

(measured vertically from

the ramp surface)

Extension: 1'-0" minimum (3)

Note:

Handrail should extend beyond top and bottom of ramp, return to a wall or post and must be parallel to ground surface.

Not less than 1 1/4" Handgrip: (4) Not more than 1 1/2" (outside diameter)

Note: Handgrip should be round or oval in cross-section, should have a smooth surface with no sharp corners, and should be uninterrupted for its entire length to provide a continuous gripping surface.

(5)Handgrip Clearance: 1 1/2"

(measured between wall and the wall-

side face of the handgrip)

k. Where there is a vertical drop at the side of a ramp, provide pedestrian guardrail. (Refer to paragraph 6. Pedestrian Guardrails.)

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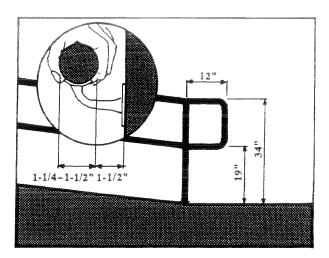
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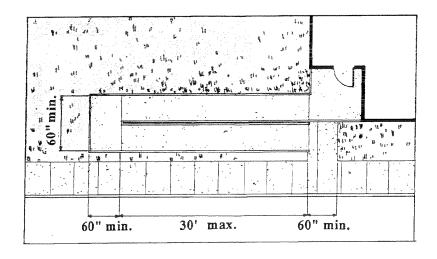
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Ramp Landings



Ramp Handrails with Extensions





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5. Stairs

Note:

The following section represents a partial summary of the design constraints for stairs. Consult the MBTA Guide to Access and relevant codes for additional information.)

Width: a.

6'-0" preferred minimum

4'-0" absolute minimum

b. Landings: Every 12'-0" of vertical rise

Length:

Equal to width of stair (4'-6" absolute minimum)

Riser Size: 6"< R <7" С.

("<" = less than)

Tread Size: 11"< T <13"

Note:

These standards represent extremes; riser-tread ratios should be calculated using the following formula:

$$2R + T = 25$$
"

The treads and risers of any stair must be of a uniform dimension. The minimum number of risers for any stair is three. and the risers themselves should be closed. Stair treads shall not have an abrupt projection of nosing.

d. Slope of riser: 1 1/4" maximum

(measured from the horizontal projection of

the tread below)

Riser to tread angle: Greater than 70 degrees

(See diagram)

- Stair treads should pitch to avoid ponding of water (a maximum of e. 1/8" per foot).
- Stair treads shall have a slip-resistant (minimum static f. coefficient of friction of 0.6), glare-free surface.
- Handrails at stairs: g.
 - Provide continuous (not interrupted by newel posts or other (1)obstructions) handrails on both sides of all stairs. When stairs are greater than 7'-4" in width, intermediate rails are required.
 - (2) Heights:

2'-10" and 1'-7"

(measured vertically from nosing)



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(3) Extension: 1'-0" minimum (top)
1'-0" minimum + length of one tread (bottom)

Note:

At the top, the extension shall be parallel to the walking surface; at the bottom, the handrail shall continue to slope for the distance of the width of one tread, then shall be parallel to the walking surface. Both handrail extensions should return to a wall or post.

Handrail extensions are not require if they would impede travel or create a hazard on the landing.

(4) Handgrip: Not less than 1 1/4" Not more than 1 1/2" (outside diameter)

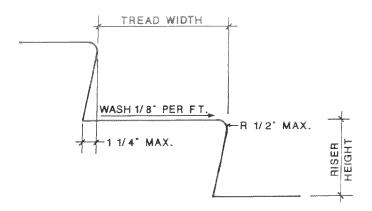
Note:

Handgrip should be round or oval in cross-section, should have a smooth surface with no sharp corners, and should be uninterrupted for its entire length to provide a continuous gripping surface.

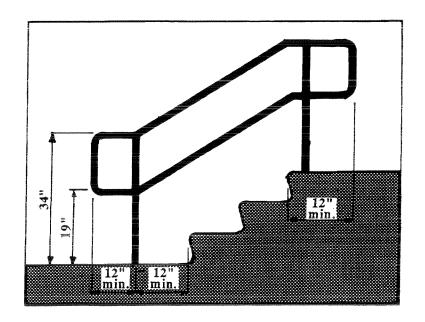
(5) Handgrip Clearance: 1 1/2"

(measured between wall and the wall-side face of the handgrip)

Stair Nosing



Stair Handrail with Extensions





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6. Pedestrian Guardrails:

Note:

The following section represents a partial summary of the design constraints for guardrails. Consult the MBTA Guide to Access and relevant codes for additional information.

- a. A pedestrian guardrail is a system of building components located on the open side of walking surfaces for the purpose of minimizing the possibility of an accidental fall from the walking surface to a lower level.
- b. Use pedestrian guardrails where required by applicable code and in the following situations:
 - (1) Where there is a direct vertical drop in excess of 4'-0" closer than 2'-0" to a walkway, parking area, or roadway.
 - (2) Along all open-sided walkways, mezzanines, and landings.
 - (3) Where there is a vertical drop at the side of a ramp or stair.
- c. Height: 3'-6" minimum (measured vertically the leading edge of the tread or from the top of the walking surface)
- d. Openings: 6" maximum opening
- e. Loading Requirements:

All required pedestrian guardrails shall be designed and constructed to meet the structural loading conditions set forth in the most recent edition of the Massachusetts State Building Code.

f. Do not use unnecessary horizontal elements that may provide an easy surface for climbing.

7. Track Crossings

The location and number of grade level pedestrian track crossings shall be determined on a site specific basis by the Authority.

Note:

Grade level crossings are not permitted at stations on high speed lines (speeds greater than 80 miles per hour).

- b. Grade level crossings:
 - (1) Pedestrian crossings should be located where pedestrian traffic is greatest. Grade level crossings should be offset from areas on the platform where the train doors are likely to align when trains are stopped for loading or disembarking passengers. Crossings should be located to be blocked when a train is stopped within the station to prevent pedestrian track crossings.
 - (2) Grade level track crossings should be offset from access points to the platform. Design layout should seek to reduce the probability of pedestrians stepping out into the crossing without looking for on-coming trains.

(3) Width:

8'-0" minimum

(4) Slope in the

5% (approx. 5/8" per foot)

direction of travel: absolute maximum

Cross Slope:

2% (approx. 1/4" per foot)

absolute maximum

Note:

The above slopes apply to walking surfaces within the crossing. The platform should slope down at a maximum slope of one in twelve (1:12) to the level of the crossing to permit access for wheelchairs and maintenance vehicles.

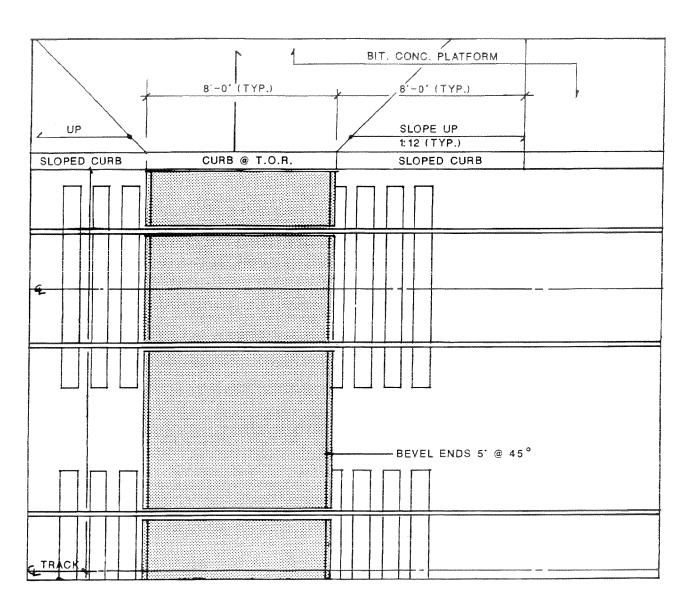
No level change greater than 1/2" is permitted unless a ramp is provided. Level changes between 1/4" and 1/2" must be beveled with a maximum slope of 1:2.

- (6) The crossing surface should be slip-resistant (maximum static coefficient of friction should be 0.6 for walking surface and 0.8 for ramped surfaces). Material should be impervious to oil and grease.
- (7) The construction of pedestrian crossing construction should be 'panelized' for ease of removal for track maintenance.
- (8) The gap between rail and adjacent track crossing surfaces shall be governed by American Rail Engineer's Association standards and shall comply with State and Federal accessibility rules, regulations and standards. The maximum permissible gap at the inner edge of each rail is 2-1/2".
- (9) Detectable warning surfaces for persons with visual disabilities shall be provided at the edge of all track crossings.

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(10) Provide fully automated crossing warning systems at each pedestrian crossing on main line tracks. Secondary and other low speed tracks may be exempted from this requirement on a site specific basis. Locate warning signs on all crossings to be visible from each entry to the crossing. These signs should have the phrase "Look Before Crossing" on both sides. (See Chapter on "Graphics" for design criteria for the standard sign.)

Pedestrian Track Crossing



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- c. Grade separated crossings:
 - (1) All new pedestrian crossings on the Providence line shall be grade separated.
 - (2) Locate new grade separated crossings where pedestrian traffic is greatest—e.g. at the midpoint of platforms or at the point of access to/from parking. Reuse existing grade separated crossings where possible.

(3) Width:

6'-0" minimum

(open, elevated crossings)

12'-0" minimum (enclosed passageways,

tunnels)

(4) Slope in the

5% (approx. 5/8" per foot)

direction of travel:

absolute maximum

Cross Slope:

2% (approx. 1/4" per foot)

absolute maximum

- (5) Grade separated structures must comply with rules and regulations governing accessibility. Access shall be provided by ramp or elevator.
- (6) All grade separated crossings shall be illuminated in accordance with the guidelines presented in Chapter "Lighting".
- (7) Elevated grade separated structures shall be enclosed with metal grating or fencing with a maximum openings of 1" between members as a means of preventing dropping or throwing debris at trains. Limit such protective enclosures to directly over the track area to facilitate snow removal.
- (8) Pedestrian bridges and associated ramps must be covered to protect against rain and the accumulation of snow on the walkway surfaces.

D. Vehicular Circulation

1. General Principles

- a. Provide the most direct roadway access possible between the entrance to the site and the drop-off/pick-up area.
- b. Where site conditions permit, vehicle access to the site should favor the inbound side.
- c. Provide convenient loop turn-arounds for drop-off/pick-up vehicles (buses, taxis, private automobiles).
- d. Roadways in public rights-of-way that are to be relocated or improved shall be designed to current standards set forth by the Massachusetts Department of Public Works and as required by local codes.

2. Vehicle Turning Radii

Note:

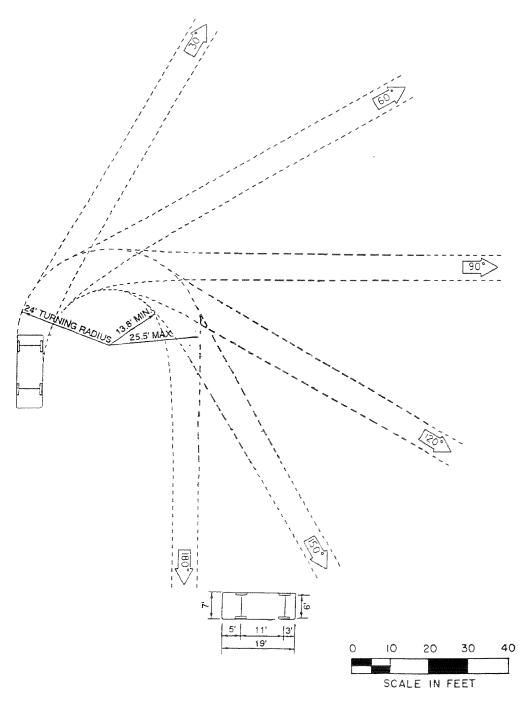
The following table is taken from the 1990 edition of <u>A Policy on the Geometric Design of Highways and Streets.</u>

Design Vehicle	Minimum	Minimum	Minimum
	Turning	Inside	Turning
	Radius	Radius	Path
Passenger Car (P)	24	13.8	25.5
Single Unit Transit Bus (BUS)	42	24.4	46.5
Single Unit Truck (SU)	42	27.8	44.1
Semitrailer (WB 50)	45	19.2	46.3

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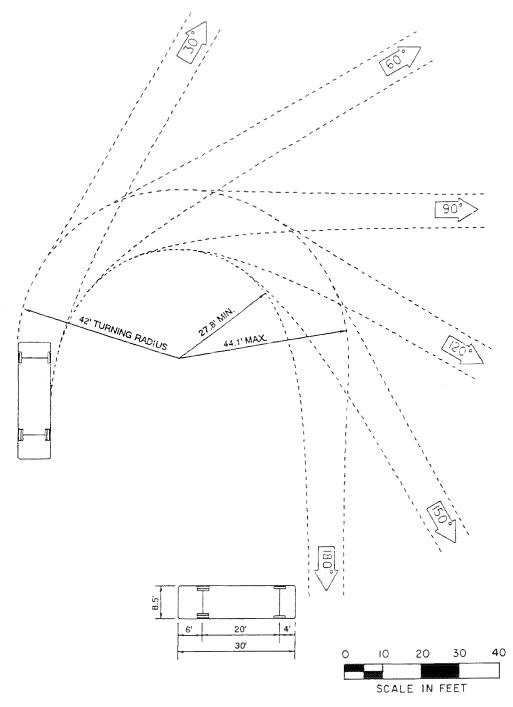
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The following diagrams are take from A Policy on the Geometric Design of Highways and Streets, 1990 ed.



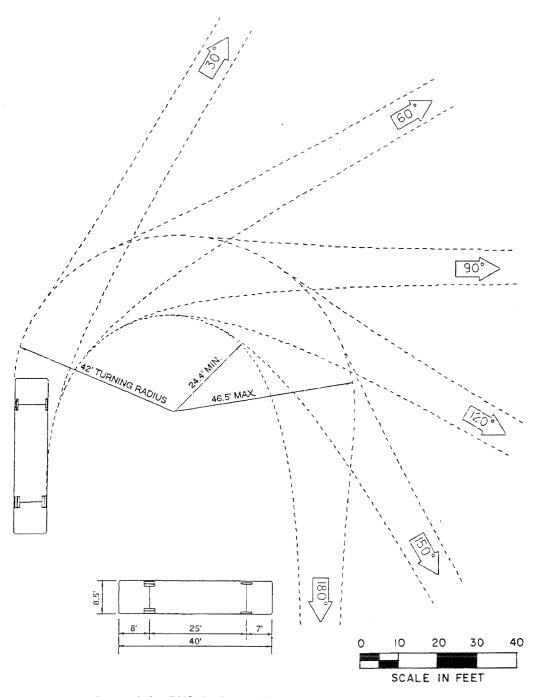
Minimum turning path for P design vehicle.

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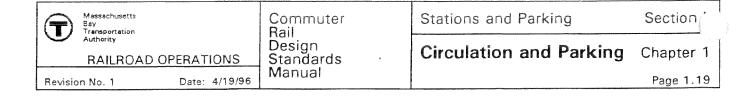


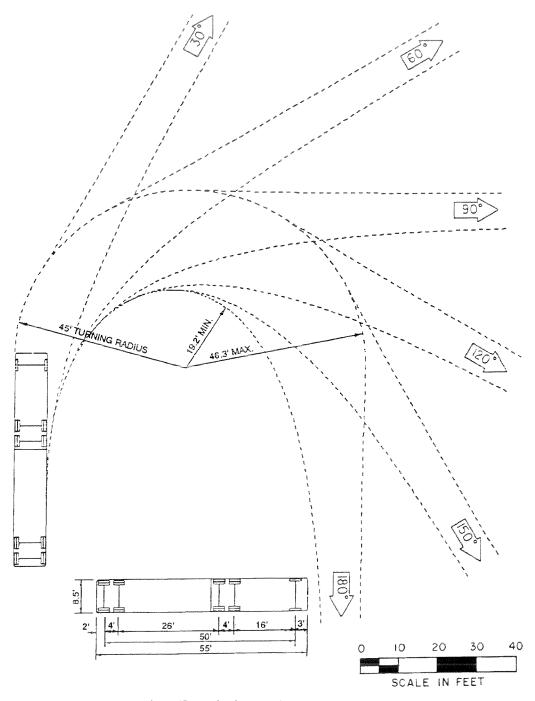
Minimum turning path for SU design vehicle.

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Minimum turning path for BUS design vehicle.





Minimum turning path for WB-50 design vehicle.

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- 3. Standard Roadway Dimensions and Gradients
 - a. The preferred minimum roadway lane width is $12^{\circ}-0^{\circ}$. The absolute minimum lane width is $10^{\circ}-0^{\circ}$. The absolute minimum lane width for a one-way single lane is $16^{\circ}-0^{\circ}$.
 - b. Roadways shall be cross pitched to provide positive drainage. The preferred cross pitch is 2% (approx. 1/4" per foot). The absolute minimum cross pitch is 1% (approximately 1/8" per foot). The maximum cross pitch is 3% (approx. 3/8" per foot). Where possible, roadways should be crowned in the middle and drain to the edges.
 - c. Roadway gradients:

Vehicle	Roadway Gradients (Slope)
Automobile	10% maximum (approx. 1 3/16" per foot) for ramps, access roadways, and driveways; 6% maximum (approx. 3/4" per foot) sustained grade for safe operation; 5% maximum (approx. 5/8" per foot) on roadways subject frequent ice, snow, sleet, and fog.
Bus	10% maximum (approx. 1 3/16" per foot) operating grade; 6.5% maximum (approx. 13/16" per foot) design gradecontrolled by safety considerations and desirable operating conditions in the winter months.

- d. Where an accessible route crosses a roadway, the maximum allowable slope in the direction of travel is 5% with a maximum cross slope of 2%.
- 4. Vehicle Entrances and Exits
 - a. The number and location of vehicle entrances and exits at a station is determined by many factors, including parking lot size, drop-off/pick-up volume, site topography, traffic volumes on adjacent streets, and adjacent land uses.

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Commuter Rail Design Standards Manual b. The recommended distance between site entrances/exits and adjacent street intersections along various types of roadways is presented below:

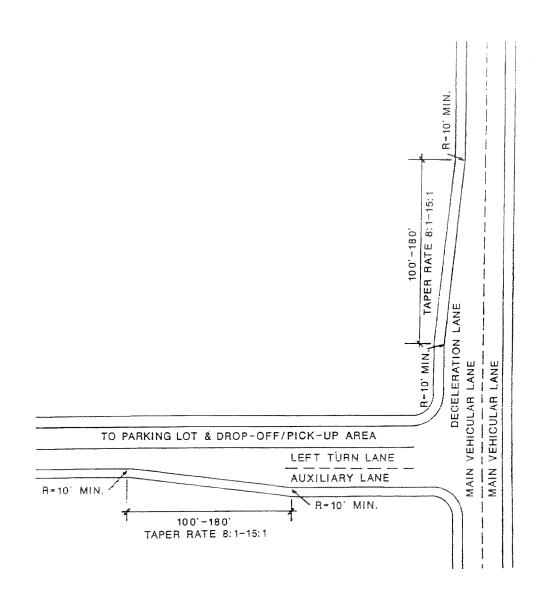
Type of	Minimum	Preferred
Roadway	Distance (ft)	Distance(ft)
Major Arterial	200	400
Minor Arterial	150	300
Collector/Local	100	200
Street	100	200

- c. Entrance and Exit Design
 - (1) At exits where a moderate number of left hand turns is anticipated, a second auxiliary exit lane should be considered to separate left and right hand turns. The preferred width of auxiliary lanes is 12'-0"; the minimum width is 10'-0". (See Diagram following.)
 - (2) Vehicle storage length is the area required to accommodate vehicles exiting the site. This area should be separate from and not interfere with the operation of vehicles in the remainder of the parking lot.
- d. For further information on the design of intersections, auxiliary lanes and deceleration lanes, see <u>A Policy on the Geometric Design of Highways and Streets</u>, published by the American Association of State Highway and Transportation Officials.

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Layout of Auxiliary and Deceleration Lanes



- 5. Drop-off/Pick-up Areas (Passenger Loading Zones)
 - a. Provide drop-off/pick-up areas at all stations, even those sites where no long term parking is provided. Locate the drop-off/pick-up area within a maximum 100 feet of the station platform and ensure compliance with the Rules and Regulations of the Architectural Access Board (AAB) of the Commonwealth of Massachusetts. Accessible drop-off/pick-up areas shall be identified with international symbol of accessibility signs.

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Note: As of the date of this writing, the requirement of the Americans with Disabilities Act Accessibility Guidelines (ADAAG) for tactile warning material at curb-side locations has been suspended.

- b. Limit the size of drop-off/pick-up areas. Without strict enforcement of parking restrictions, all-day parkers will utilize drop-off/pick-up areas. Parking lot aisles can be used for queuing of vehicles waiting to pick up passengers.
- c. Drop-off/Pick-up Area Layout:
 - (1) The drop-off area must be designed for accessibility, providing a 5'-0" wide aisle space between the vehicle and the curb over its full length. Provide curb cuts within the drop-off area.

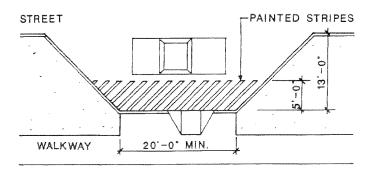
Drop-off areas should be designed for right-hand curbside drop. (See Diagram)

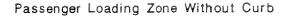
Where passengers transfer from local bus lines to commuter rail, a bus drop-off/pick-up area with a berth size of 80'-0" by 11'-0" should be provided.

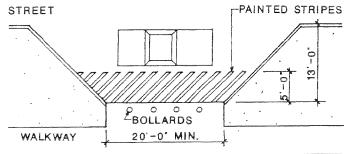
At bus stops where a lift will be deployed:

- Provide firm, stable surface a minimum clear length of 96" measured from the curb or vehicle roadway.
- Provide minimum 60" clear width, measured parallel to vehicle and roadway.

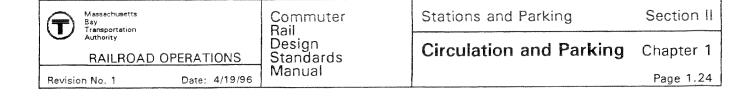
Passenger Loading Zone







Passenger Loading Zone With Curb



E. Parking Lot Layout

General Principles

Factors such as site topography, location of access roads, land availability, adjacent land use, and community requirements will determine in large part the layout of parking facilities. However, other factors to consider in the initial planning for parking lots are:

- a. Where possible, parking layout should be designed to maximize use of the accessible route to the platform. At low platforms, this is typically toward the outbound end, where the access platform is located.
- b. Avoid dead end aisles unless a turnaround is provided.

Where turnarounds are not possible in dead-end aisles, provide one striped space and sign it as a "turning-space-only" to eliminate the need to back out the length of the parking lot.

Provide for snow removal at the end of dead end aisles.

2. Parking Layout

a. Bay Orientation

Site conditions permitting, parking bays should be laid out perpendicular to the track and platform to allow people to walk down the aisles to the platform.

(As a rule of thumb, if a site has a curb to curb dimension measured at right angles to the track which is greater than 200 feet, the parking bays should be perpendicular to the track and platform. However, there may be specific site conditions or circulation requirements which dictate an orientation parallel to the track and platform.)

b. Parking Stall Orientation

90 degree parking is preferred. Use diagonal parking only when 90 degree parking is not feasible. Diagonal parking should not be used in structures. Follow accepted standards for diagonal parking such as the Handbook of Landscape Architectural Construction, published by the Landscape Architecture Foundation.

c. Perimeter Parking

Use 90 degree parking around the entire perimeter of the site where possible to maximize the capacity of the lot.

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Dimensional Guidelines 3.

General Notes:

Deviations from the dimensional guidelines shown in the accompanying diagram may be permitted in site-specific situations, however it is the responsibility of the design consultant to bring such deviations to the attention of the Authority for review and approval.

90 degree parking spaces may be shortened by up to 2'-0" where vehicles can overhang the curb. Vehicle overhangs must not interfere with the required clear width of an accessible pathway.

Avoid single row parking in parking structures.

Standards for 90 degree Parking for Use by the Physically b. Disabled

Provide minimum 8'-0" wide spaces with an adjacent 5'-0" wide striped access way. Depth, aisle, and bay dimensions should comply with those requirements for parking lots and structures of the Rules and Regulations of the AAB and the ADAAG.

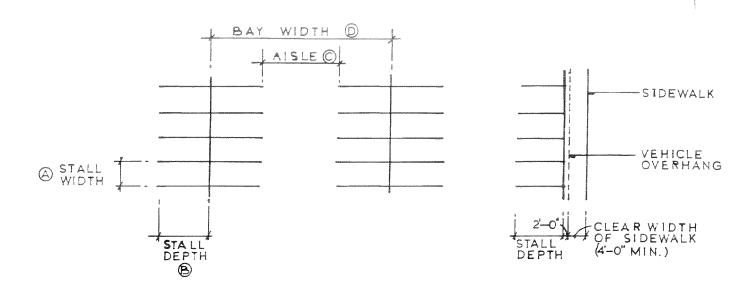
Two spaces may share the same 5'-0" access way. Provide sidewalk ramps as necessary at the end of access ways to connect with the accessible route to the platform. Where accessible spaces are grouped together, it may be advantageous to lower the sidewalk to the level of the parking spaces. Accessible parking spaces and access aisles shall have surface slopes not exceeding 1:50 (2%) in all directions.

Standards for Parallel Parking on Surface Lots С.

Use parallel parking only where other layouts are impractical. Do not use parallel parking in any location where it might interfere with heavily traveled vehicular access routes.

Parallel parking spaces should be 8'0" wide by 22'0" long.

Standard Parking Stall Layout

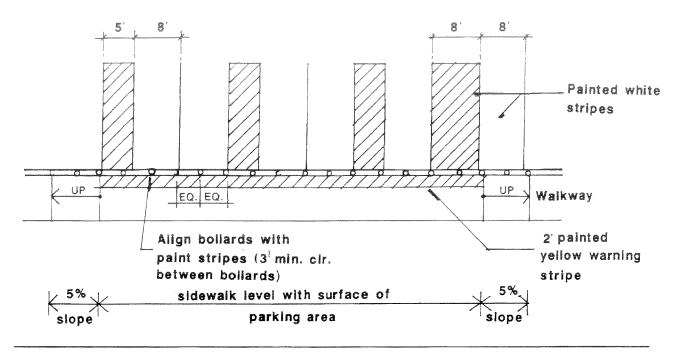


	TWO ROWS OF CARS			ONE ROW OF CARS		RS
	STAND	ARD	COMP.	STANDARD CC		сомр.
90° PARKING IN SURFACE LOTS	PREF.	ALT. BAY < 60 FT.		PREF.	ALT. BAY < 43 FT.	
	8'-3"	8'-6"	8'-0"	8'-3"	8'-6"	8'-0"
B STALL DEPTH	17'-0"	17'-0"	15'-0"	17'-0"	17'-0"	15'-0"
O AISLE	26'-0"	24'-0"	24'-0"	26'-0"	24'-0"	24'-0"
D BAY WIDTH	60'-0"	58'-0*	54'-0"	43'-0"	41'-0"	39'-0"
90° PARKING IN PARKING STRUCTURE						
STALL WIDTH	8'-6"	N.A.	N.A.	8'-6"	N.A.	N.A.
B STALL DEPTH	17'-0"	N.A.	N.A.	17'-0"	N.A.	N.A.
O AISLE	26'-0"	N.A.	N.A.	26'-0"	N.A.	N.A.
O BAY WIDTH	60'-0"	N.A.	N.A.	43'-0"	N.A.	N.A.
COL SPACING	58'-0"	N.A.	N.A.	41'-0"	N.A.	N.A.

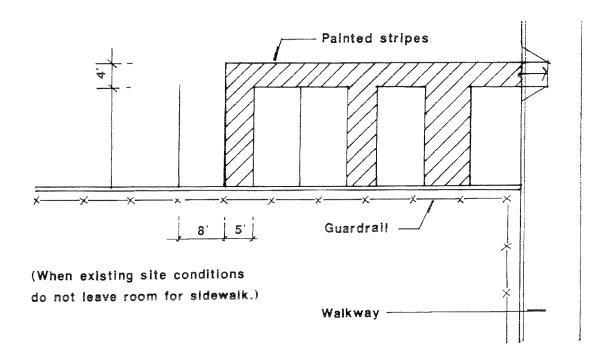
^{*} CONSULT HANDBOOKS FOR DIAGONAL PARKING LAYOUTS. (E. G.: <u>ARCHITECTURAL</u> <u>GRAPHIC STANDARDS</u> OR <u>HANDBOOK OF LANDSCAPE ARCHITECTURAL CONSTRUCTION</u>)

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Accessible Spaces Without Curb



Access Through Parking Area



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4. Accessible Parking

- a. The rules and regulations of the Architectural Access Board (AAB) of the Commonwealth of Massachusetts apply to the modernization or expansion of commuter rail parking facilities, including surface lots and garage structures. Federal regulations also require accessible parking be provided at these facilities.
- b. The MBTA <u>Guide to Access</u> addresses accessible parking at commuter rail stations. Accessible parking spaces must comply with Section 23 of the Rules and Regulations of the Architectural Access Board of the Commonwealth of Massachusetts and Section 4 of the Americans with Disabilities Act Accessibility Guidelines.
- c. Provide accessible parking spaces as follows:

Total No.Parking Spaces	Required No. Accessible
	Parking Spaces
1-25	1
26-50	2
51-75	3
76-100	4
101-150	5
151-200	6
201-300	7
301-400	8
401-500	9
501-1000	2% of total
1001 & over	20 + 1 for each 100 over 1,000

Note: One in every eight accessible spaces, but not less than one, shall be served by a minimum 96 in. access aisle and be designated "van accessible" as required by ADAAG 4.6.4.

Where there is more than one parking lot provided on the same side of the track, it is acceptable to place all accessible parking spaces in the parking lot closest to the platform. However, in such case, the total number of accessible spaces must be computed on a lot by lot basis and added together. They may not be computed from the total number of spaces in the lots. Provide signage at the auxiliary lots to indicate where the accessible parking spaces are located.

Where multiple lots are provided on both sides of the track, a proportionate number of accessible parking spaces must be placed on both sides of the track. If this is not possible, a variance must be obtained from the Massachusetts Architectural Access Board. Where there is more than one lot, the number of accessible parking spaces is calculated on a per lot basis.

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5. Gradients

a. The absolute maximum parking lot gradient is 5% (approx. 5/8" per foot). The absolute minimum acceptable gradient is 0.5% (approx. 1/16" per foot); the preferred minimum is 1% (approx. 1/8" per foot).

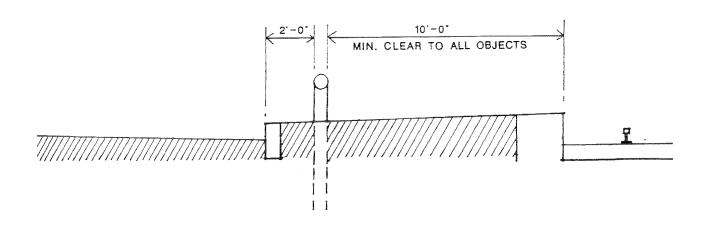
Where an accessible route occurs within the parking area, the maximum slope is 5% with a maximum cross slope of 2% except at aisles between accessible spaces.

b. Crown the pavement in each parking bay at the center and pitch to the outside edges to avoid water ponding within aisles where pedestrians will walk.

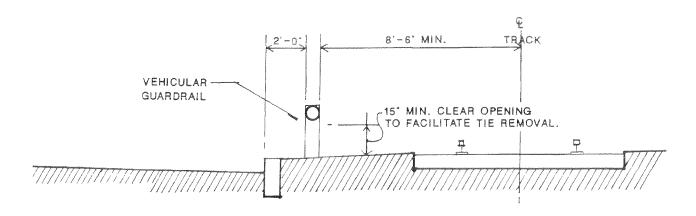
6. Clearances

- a. To allow for vehicle overhang, the minimum clearance between the inside face of curbing in a parking lot and any object (such as signs, light poles, trees, fences and barrier walls) is 2'-0".
- b. Where parking is adjacent to track without a platform, provide vehicular guard rail mounted with chain link fence at a minimum of 8'-6" from the center line of track. Where vehicular guard rail is located less than 12'-6" from track centerline, provide a 15" clear space under the guard rail to facilitate cross tie replacement.

Typical Minimum Clearances, Low Platform

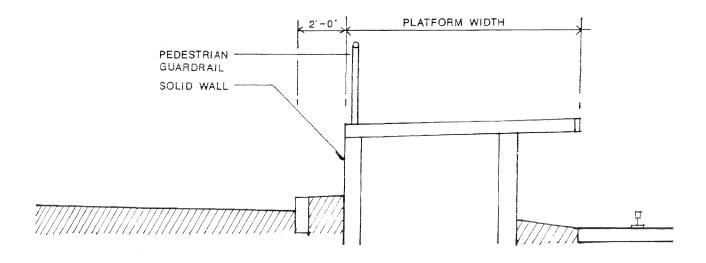


Minimum Clearance at Track, No Platform



NOTE: WHERE RETAINING WALLS OCCUR ADJACENT TO TRACK, PROVIDE A MINIMUM CLEARANCE OF 12'-0' FROM CENTERLINE OF TRACK FOR REMOVAL OF TIES.

Typical Minimum Clearances (Platform More Than 8" Above Adjacent Surface)



NOTE: FOR HIGH LEVEL PLATFORMS WITH SIDE PANELS WHICH ARE EASILY DAMAGED, PROVIDE A RAISED CURB 2'-0" AWAY FROM THE SIDE OF THE PLATFORM.

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7. Pedestrian and Traffic Islands

- a. Avoid islands since they make snow removal more difficult, increase cost, and complicate drainage. Provide painted islands at the end of bays; raised islands impede snow removal.
- b. General Guidelines (if needed)
 - (1) Islands should be a minimum of 4'-0" wide.
 - (2) Use long islands perpendicular to parking stalls only when necessary for grading or circulation. Provide 8' to 10' wide breaks at every other parking bay (approx. 120' intervals) to allow for plowing and pedestrian access.
 - (3) Avoid curbed inside corners since they make plowing difficult, trap debris and increase the number of drainage structures needed.

F. Use of Landscape Buffers

- 1. See Chapter 6 for specific design criteria governing the appropriate use of landscape buffers. In general, the Authority prefers to minimize unnecessary landscaping at commuter rail stations.
- 2. Where appropriate, lay out parking lots to preserve significant natural features—specimen trees, natural berms, outcroppings, etc—which may enhance the visual characteristics of the site. Such features should not detract from the operation, security, and capacity of the lot.
- 3. Lay out parking areas to leave sufficient space at the perimeter of the site to provide a buffer from surrounding neighborhoods or other sensitive receptors.

G. Use of Barriers

1. Use barriers in station parking areas to channel vehicular and pedestrian traffic, contain water run-off, and, in certain instances, limit pedestrian access to the site. Barriers should be used to maintain a safe separation between platform and vehicular circulation and parking. Typical barriers include curbing, guard rail, bollards, and fencing. (Conditions which govern the use of barriers are described below.)

2. Types of Barriers:

a. Curbing

Curbing is the preferred method of defining the limits of a parking lot. Use curbing to control water run-off, to separate

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pedestrian and vehicular traffic, and to confine vehicle movements.

Granite is preferred as a curb material (7" maximum vertical reveal). Consider sloped granite as an alternative to vertical granite, but do not use sloped granite in areas of pedestrian circulation. Existing on-site granite curbing may be reused where possible.

If the lot can be easily drained to nearby ditches curbing may not be desirable. Guard rail or bollards should be used to confine vehicles to the paved lot where no curbing is provided.

Do not use the railroad right of way ditch for drainage of the parking area.

b. Vehicular Guard Rail

Vehicular guard rail is used to confine vehicle parking to specific areas. Under certain conditions, it is advisable to provide both curbing and guard rail (or bollards) as a secondary safety barrier (e.g. at the edge of an embankment).

c. Bollards

Use bollards for the same purposes as guard rail. However, bollards allow the free flow of pedestrians between them. Bollards interfere with snow plowing operations requiring either hand shoveling or the use of small machines. Therefor, their use should be minimized to short segments only where necessary.

d. Pipe Rail

Pipe rail may be used for pedestrian guardrails and as a means of channeling pedestrian movements. Typical applications occur along the back face of platforms with vertical drops in excess of 8", along the top side of retaining walls, and at stairs and ramps. Consult the pedestrian guardrail section of this chapter for design criteria.

e. Fencing

Use fencing to limit pedestrian access to the site for safety and security reasons. Fences adjacent to roadways and/or parking lots should be set back and protected by curbing or vehicular guardrail to allow for vehicle overhangs and the storage of plowed snow. Provide curbing or vehicular guardrail.

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f. Inter-track Fencing

Inter-track fencing is chain link fence installed between tracks to prevent pedestrians from crossing the tracks except at designated locations.

Inter-track fencing should 4'-0" high and extend a minimum distance of 200'-0" beyond the ends of the platforms. Consult Standard Plan No. 3204 for design criteria.

H. Parking Area Drainage Requirements

1. Authority policy is to install a storm drainage system in all new parking lots as well as those being upgraded.

Only small parking lots (generally those with under a twenty-five vehicle capacity) surrounded by porous soil capable of absorbing water run-off form the parking area may be designed without a storm drainage system. Do not drain toward the track right of way under any circumstances.

2. Storm drainage systems should conform with the Massachusetts Department of Public Works standards. See the Landscaping subsection for a description of drainage system design guidelines.

I. Parking Fee Collection

- At stations where a parking fee is to be collected, the Authority uses a central coin-slot system to collect parking fees.
 - a. The central coin-slot system consists of a centralized parking fee depository with numbered coin slots which are keyed to numbered spaces in the parking lot. The user deposits the fee as he or she walks to the platform. (See diagram following)

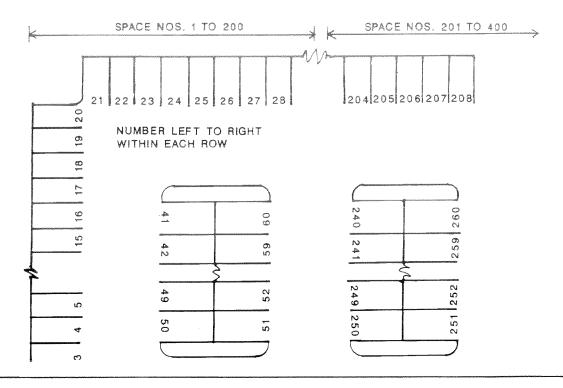
Location of the central collection box shall be determined by the Authority. Where possible, the central collection box should be highly visible and should be located under a canopy and on the same side of the track as the parking in a central area adjacent to the inbound platform. In larger parking lots, divide the lot into numbering zones of not more than 200 spaces. (See diagram following)

See <u>MBTA Guide to Access</u> for guidelines on how to make collection boxes accessible to the physically disabled. Collection boxes must be located on an accessible route.

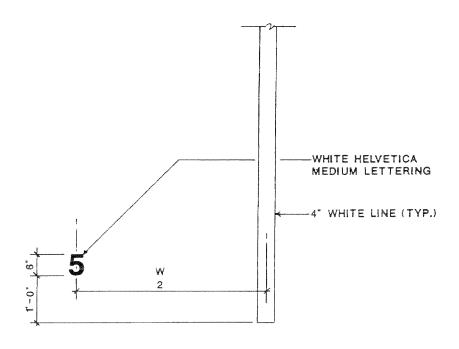
b. Parking spaces should be clearly marked and numbered consecutively.

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Parking Space Numbering For Fee Collection

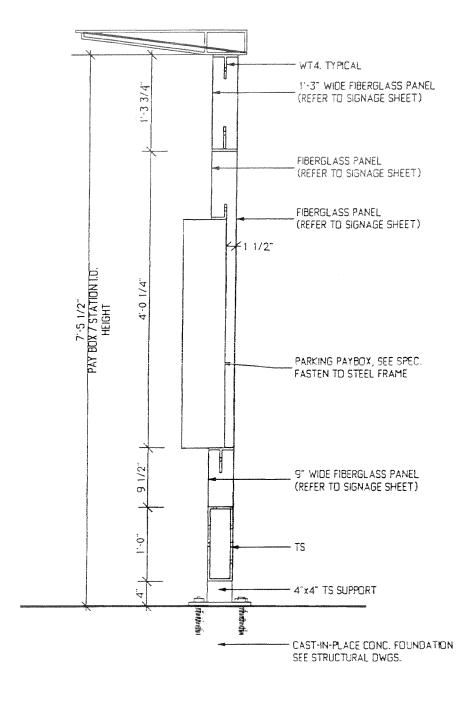


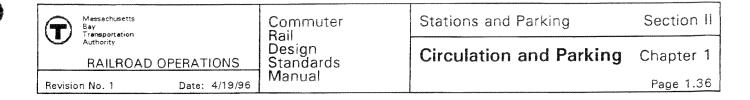
Example of Space Numbering



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Elevation of Cash Box Panel





IV. REFERENCE STANDARDS

Consult the following reference standards for more information:

- Architectural Graphic Standards, by Ramsey and Sleeper, Edited by the American Institute of Architects, Published by John Wiley and Sons.
- Handbook of Landscape Architectural Construction
- Mass D.P.W. Standard Specifications for Highways and Bridges (1988 Ed.)
- MBTA Guide to Access
- MBTA <u>Standard Specifications</u>
- A Policy on the Geometric Design of Highways and Streets, Published by the American Association of State Highway and Transportation Officials.

V. PREFERRED MATERIALS

A. Paving Materials

<u>Material</u>	<u>Comments</u>
Bituminous	The Authority prefers to use bituminous Concrete to pave parking lots because it is durable, inexpensive, and easily repaired. See details Mass DPW Standard Specifications for Highways and Bridges.

B. Curbing Materials

Material

Granite

The Authority prefers to use granite curbing in parking lots because it resists damage from salt and snowplows.

Bit. Conc. Swales

Used to channel runoff to a catch basin when a more substantial curb is not required; formed integrally with paving. Often used in combination with guard rail.

C. Barriers

Material Comments

Vehicular Guard Rail Used to confine vehicular traffic to

Used to confine vehicular traffic to designated areas. May be either galvanized steel highway guardrail or heavy duty steel

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pipe rail. See Mass DPW Standard Specifications for Highways and Bridges.

Bollards

Used to confine vehicular traffic while allowing pedestrians to pass through. Use concrete-filled galvanized steel pipe. Height varies:

2'-0" when used with a curb
2'-6" when used to define the edge of a parking area
4'-0" when used as a barrier (e.g. to close off a road)

Fencing

Used to limit access to a restricted area for security reasons, or to channel pedestrian traffic. Typically galvanized steel wire mesh. MBTA Standard Specifications.

Pipe Rail/Guardrail

Used to channel pedestrian flows and to minimize the possibility of an accidental fall from an elevated walking surface. Consult section on pedestrian guardrail for design criteria.

D. Striping Materials

Material

Comments

Roadway Marking Paint

Use roadway marking paint within the station to delineate traffic lanes, parking spaces, parking space numbers, crosswalks, etc. See Mass DPW <u>Standard Specifications for Highways</u> and Bridges.

CHAPTER 2
CANOPIES AND PLATFORMS

I. INTRODUCTION

This section establishes design objectives, guidelines, and design criteria for the construction of new shelters and platforms at commuter rail stations. Both high and low level platforms are discussed.

The objectives and guidelines presented below are a response to user needs and to the practical operating and maintenance requirements of the Authority. Surveys have indicated that shelter is the most important feature of a station to the commuter rail user.

II. DESIGN OBJECTIVES

Comfort, safety, efficiency, and durability are the principal objectives to be considered in the design of platforms and shelters at commuter rail stations. The station shelters function primarily as a protection from the elements. However, they should be designed to include good lighting, visibility from both the inside and out, as well as multiple means of egress to enhance the users sense of safety. These objectives should also address specific issues of maintenance and snow removal.

III. DESIGN GUIDELINES

A. PLATFORMS

LOCATION

- a. All commuter rail stations should have a paved platform(s).
- b. A major consideration in determining platform location is achieving maximum visibility of the platform from the surrounding area for security reasons. Access should be as direct as possible from the surrounding area and parking lot.
- c. Platforms should be located to avoid conditions where a stopped train or a grade crossing gate will back-up local traffic on the crossing street (see illustration). The preferred platform arrangement at stations adjacent to grade crossings is a split configuration in which trains pull beyond the grade crossing far enough to clear the crossing signal circuit. Where this arrangement is not feasible, the preferred alternative is a configuration locating both platforms on the outbound side of the crossing. This arrangement clears the crossing during the evening period when traffic is typically heaviest.
- d. Locate platforms so that trains held at interlocking signals can load/unload.
- e. An important consideration in the location of platforms is the topography and access for maintenance and snow removal equipment.

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It is not desirable to locate platforms where the right-of-way topography is severe, since this will require the construction of retaining walls that will increase the cost per linear foot of the platform.

SAFETY

- a. Platforms should have adequate space for passengers gathering on the platform and waiting in line to board the train during peak times.
- b. Platform areas should be well lighted and drained and should have a slip-resistant surface.
- c. The track side edge of the platform must have a tactile warning strip.
- d. Minimize the number of obstructions on the platform to insure maximum visibility of the platform by the train crew, as well as to insure good pedestrian flow and access of maintenance vehicles.

EFFICIENCY

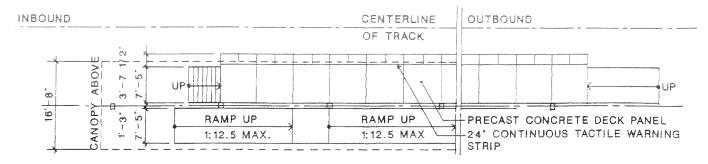
- a. Access to platforms should be highly visible and direct from drop-off/pick-up points and pedestrian walkways.
- b. Platforms should be free of columns, utility poles, and other objects impeding free pedestrian flow.

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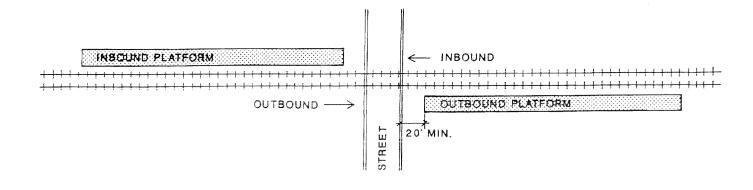
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Platform Location Diagram

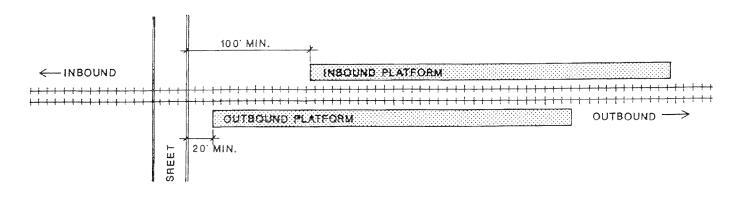


<u>Note</u>: Coordination of track alignment and profile with the precast concrete station platform is critical! Track alignment and profile must be surveyed and verified by Massachusetts licensed surveyor.

Preferred Arrangement of Platforms at Grade Crossing



Alternative Arrangement of Platforms at Grade Crossing

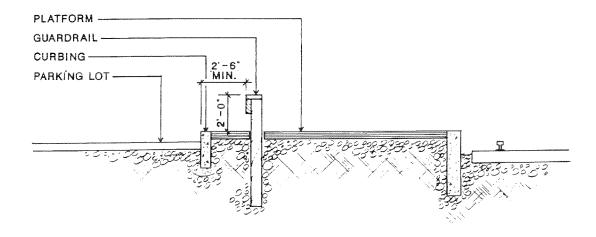


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USE OF BARRIERS

- a. Provide barriers along the back face of a platform under the following conditions:
 - Where there is a sharp drop in elevation exceeding 2'-0".
 - Where active freight tracks are located behind the platform. Random pedestrian crossing of these tracks is a potential safety hazard that can be minimized trough the use of a barrier that channels pedestrian movements to specific points.
 - Where a parking lot abuts the platform. Under this condition the barrier serves as a primary or secondary deterrent to vehicle access to the platform. When a barrier system such as a guard rail is used in this situation it may also double as a sitting area for waiting passengers, as the accompanying detail illustrates.
- b. Typical barrier systems that might be used along the back face of a platform include pipe rail, guard rail, and wire mesh fencing. The choice of system will depend on factors such as the magnitude of the safety problem (i.e. protecting a person from a ten foot fall or it may simply be a reminder to cross tracks at a specified location) and specific project funding limitations.

Detail of Barrier System Limiting Vehicle Access to Platform Area





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B. SHELTERS

GENERAL

- a. Canopy structures should provide overhead and wind protection along portions of the platform(s). When combined with a vertical windscreen panel, the canopy provides the user a moderate amount of protection from rain, snow, and wind. At the same time, it is a relatively economical and low-maintenance form of shelter.
- b. It is not economically feasible to provide heat in this type of open-air shelter.

2. LOCATION

- a. New shelters should be located on or adjacent to the platform in areas that are the most visible from adjacent streets and neighborhoods. For low level platforms, canopies must be provided for the protection of access paltforms and ramps. Generally a second canopy should be provided at a central location on the low platform. High level platforms may only require a single shelter, however the location(s) must provide for the protection of any access ramp(s) serving the platform(s).
- b. New shelters should also be located on the most directly accessible route from the site entrance(s) to the platform when this location does not conflict with the high visibility guidelines described above.
- c. New shelters should be designed and located in a manner that does not obstruct the visibility of the conductors in the approaching trains.

CONVENIENCES

A detailed description of the types of conveniences that should be provided appears in the Comforts and Conveniences chapter.

4. LIGHTING

Lighting design guidelines for buildings and canopies are presented in the Lighting chapter of this manual.

C. ACCESSIBILITY FOR SHELTERS AND PLATFORMS

- 1. All shelters and platforms should be readily accessible via primary site entrance/exit.
- 2. Persons with disabilities must have full access to all shelters and platforms, as specified in the Rules and Regulations of the

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Massachusetts Architectural Access Board, Americans with Disabilities Act Access Guidelines, and the MBTA Guide to Access. For 'key' station sites, refer to ADAAG Section 6, the MBTA Guide to Access and consult with the Authority for specific requirements. Some of the requirements pertaining to shelters are summarized below.

- a. The approach to the primary entrance/exit of all shelters shall be uninterrupted by steps. If there is a change of elevation, a ramp will be provided in conformance with the ramp design requirements described in the Circulation subsection of this manual.
- b. Access should be as direct as possible from the surrounding area and parking lot to platform.
- c. New stations shall have full length high level platforms.

IV. DIMENSIONAL GUIDELINES

A. PLATFORMS

ELEVATION

- a. The standard height of low-level-platforms is 8" above top of rail on non-super-elevated tracks; the horizontal clearance between the centerline of track and the track-side face of a low-level platform curb shall be 5'-1" on tangent track. Minihigh level platforms are required on the outbound end of low level platforms.
- b. The standard height of high level platforms is 4'-0" above top of rail on non-super-elevated tracks; the horizontal clearance between the centerline of track and the track side of a high level platform shall be 5'-7" on tangent track. This horizontal dimension applies only to locations where freight clearance is not a problem.
- c. Mini-High level platforms requiring additional freight clearance shall be equipped with a "flip-up" platform edge (Consult the Authority for details of this special edge detail).

2. LENGTH

- a. Unless otherwise directed, platforms must accommodate a 9 car train. On low platforms, the access platform (mini-high) is included in the length of the platform.
- b. The length of outbound platforms should be equal to the length of the longest train serving the station plus a 20'-0" allowance for a train overshooting or undershooting the platform. The intention is to provide disembarking passengers the opportunity

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to exit the train directly from any coach. Typically, trains are 2 to 12 coaches in length. The following formula can be used to calculate outbound platform length:

- Number of coaches on longest train x 85'-0" + 20'-0"= length of platform. (In general, design for 9 cars unless directed otherwise).
- The length of the inbound platform may be shorter than the С. It is standard MBTA practice to run the longest train. locomotive always on the "country" or outbound end of the train set. As a result, the engineer on an inbound train in the control cab of the front car of the train set is always blocking passenger access to the front door of the first car. However, the rear door of the first car remains accessible. The inbound platform may therefore be 55'- 0" shorter than the length calculated by the above formula for the outbound platform.
- The absolute minimum platform length is 2 coach modules + 20'-0" d. or 190'-0".

3. WIDTH

- Platforms should be sufficiently wide to comfortably accommodate a. peak loading requirements. The width is also affected by line, available space, and ridership only at short platforms. Adequate comfort levels for waiting and boarding movements can be achieved at a maximum density of 5 sq. ft. per person. As the following example illustrates, the maximum density level will rarely be approached at commuter rail stations.
 - Assume a peak train boarding level of 200 people (about 1/3 system stations average this number or more). At a density of 7 sq. ft. per person, the space requirement is 1.400 sq. ft. Assume an absolute minimum length platform that is 190'-0" long and 10'-0" wide. The effective width of the platform (allowing for 2'-0" safety clearance at the track side face of the platform) will be 8'-0"and the effective area of the platform will be 1,520 sq. ft. or in excess of the 1400 sq. ft. minimum. With platforms generally in the range of 700-800 feet in length, standing/boarding capacity is normally of no concern.
- The preferred platform width is 12'-0"; 10'-0" is acceptable and b. 8'-0" is the absolute minimum width.
- For reasons of economy, long platforms may be tapered at the ends c. to a minimum width of 8'-0".
- The preferred island platform width is 22'-0" for a minimum of d.

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1/2 the platform length. Ends of island platforms may taper to a minimum width of 12'-0".

4. GRADIENT

Platforms should comply with accessibility regulations which state that the cross slope (the slope perpendicular to the direction of the tracks) can be a maximum of 2%; or not exceeding 1 ft. of rise for every 50 ft. of run.

WARNING STRIPE

All platforms must have a 24" yellow tactile warning strip running the length of the platform to comply with ADA access guidelines. Tactile warning strip should not be installed at low level platform ends.

B. SHELTERS

1. Size

- a. The sheltered area at each station should accommodate approximately sixty percent of the passengers boarding at times of peak volume. This figure reflects two considerations: first, that about twenty percent of the passengers either wait in their automobiles or arrive at the last minute and do not use the shelter. Secondly, economic considerations do not allow the Authority to fully accommodate peak period needs.
- b. The optimal size of the platform canopy should be determined as follows:
 - Assume no shelter is currently at the station.
 - Number of passengers using peak volume train = 100.
 - Design capacity of shelter = 60 % of 100 = 60
 - Net area required = 60x7 sq. ft. = 420 sq. ft.
 - \circ Gross area required = 420x1.05 = 447 sq. ft. or approximately 400-450 sq. ft. of shelter.

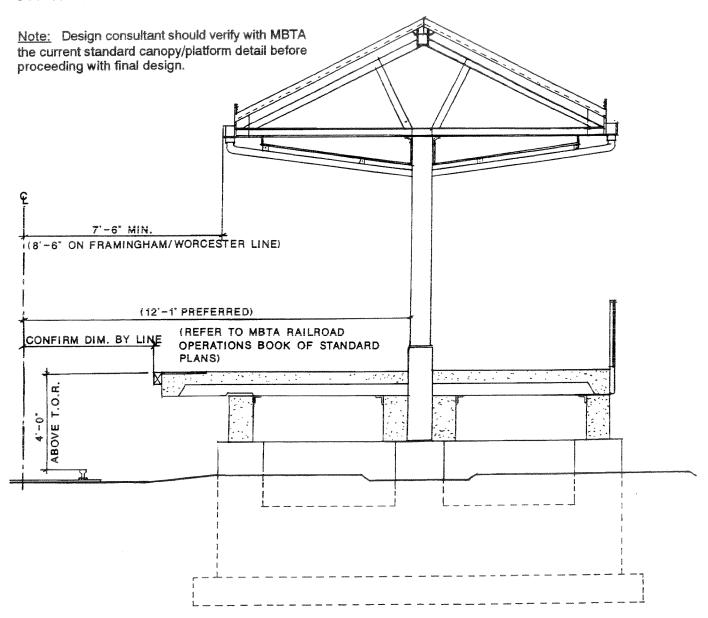
2. MINIMUM CLEARANCES

- a. The preferred minimum horizontal clearance between vertical support for a canopy and the track-side edge of platform is 10'-0". The absolute minimum is 8'-0".
- b. The minimum horizontal clearance between a canopy roof overhang and the centerline of any track is 7'-6" (8'- 6" on the Framingham/Worcester Line) except where the canopy is at a height that overhangs operating equipment. The minimum clearance from the track centerline to face of canopy columns, wall, or other obstruction is 15'-1".

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- c. The minimum clearance between the floor and the vertical panel in a canopy is 6". This clearance prevents the accumulation of leaves and debris in corners of the canopy.
- d. The vertical clearance from the top of rail to the bottom face of the canopy adjacent to track is 12'-1".
- e. Refer to MBTA Railroad Operations Book of Standard Plans, Roadway and Track for further clearance information, drawing No. 1013 in particular for station requirements.

Detail of Minimum Shelter Clearances



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V. DESIGN CRITERIA AND DETAILS

A. PLATFORM

1. PAVING MATERIALS

High level platforms shall be architectural precast concrete. Please refer to structural drawings provided by the Authority for reinforcing, connections, and bearing. Low level platforms are constructed of bituminous concrete with timber or pre-cast concrete curbing. Design and construction of all work shall conform to the following:

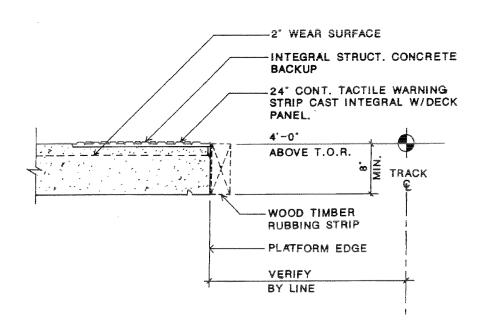
- MBTA Standard specifications including special provisions
- Massachusetts Building Code, 5th edition
- Americans with Disabilities Act Accessibility Guidelines (ADAAG)
- Rules and Regulations of the Architectural Access Board (AAB) of the Commonwealth of Massachusetts

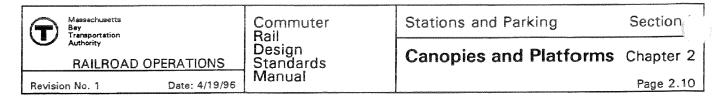
In case of conflict between the codes, standards, regulations, specifications, general notes and/or manufacturer's requirements use the most stringent provisions.

PLATFORM CURBING WITH TACTILE WARNING

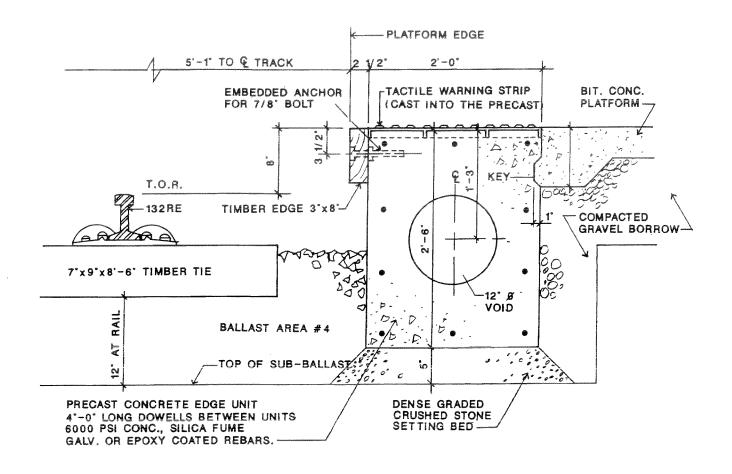
Platform curbing is essential to the creation of a safe and durable transition between the train and the platform. All platforms must be curbed with a 24" tactile warning strip. See accompanying details for precast and timber curbing

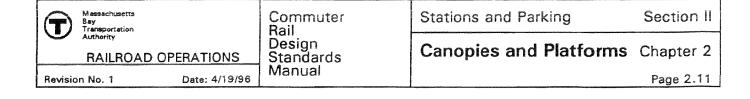
Precast Concrete Edge for Commuter Rail High Platforms





Precast Concrete Edge Unit for Commuter Rail Low Platforms





3. BARRIERS

- a. Pipe Rail: should be used to channel pedestrian movements, not as a safety barrier. Typical details are presented in the Circulation chapter.
- b. Guard rail: should be either galvanized steel, heavy timber, or either type of rail used in conjunction with concrete posts. Steel guard rail should conform with the MDPW <u>Standard Specifications for Highways and Bridges</u>, Division III, Section M8. Heavy timber guard rail is typically less expensive than galvanized steel and should be of a type similar to that described in the Circulation chapter.
- c. Fencing: A wire mesh type of fencing may be used in certain platform locations. Standard Authority details for wire mesh fencing are shown in the Circulation chapter.

B. SHELTERS

The MBTA has established design standards that specify the appropriate materials and types of construction that must be used for shelters. This documentation may be obtained directly from the Authority.

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I. INTRODUCTION

This section describes commuter rail station illumination requirements. Station area illumination is a critical factor in the enhancement of the rider's comfort and perception of safety. Therefore, careful consideration to both the quality and quantity of light is necessary.

II. DESIGN OBJECTIVES

Security, visual comfort, compatibility with surrounding uses, efficiency, and attractiveness should be addressed in the design of commuter rail station site lighting.

A. SECURITY

The primary function of lighting is to make the commuter rail station and site safe and secure, as well as visible from surrounding areas.

B. EMPHASIS

Highlighting should be used to emphasize potential hazards, informational signage, and major focal and access points which include:

- Stairs
- Ramps
- Vehicular and pedestrian track crossings
- Platforms
- Pedestrian crosswalks
- Tracks
- Shelters
- Drop-off/pick-up areas
- Building entrances and exits
- Vehicular entrances and exits
- Signage

C. VISUAL COMFORT

To insure visual comfort, station and site lighting should:

- Provide the appropriate level of lighting.
- Provide the appropriate contrast between lighting levels.
- Minimize glare. Light sources should not be located within the normal visual angle of pedestrians or drivers.
- Minimize reflected glare from smooth surfaces, such as signs.

D. COMPATIBILITY WITH SURROUNDING USES

Station and site lighting should not interfere with:

- Adjacent residential neighborhoods
- Train operation and signals
- Operation of vehicles off-site

E. EFFICIENCY

One consideration in the selection of lighting type should be its lifetime cost. This includes the cost of purchase, installation, operation, maintenance, and replacement of lamps and standards.

F. ATTRACTIVENESS

Commuter rail station and site lighting hardware should be:

- Compatible in appearance with the surrounding environment.
- Durable under the following conditions: extreme weather conditions, vandalism, dirt accumulation, and limited maintenance.

III. DESIGN GUIDELINES

A. ILLUMINATION LEVELS

The following illumination levels satisfy the objectives discussed above. However, the designer may deviate from the standards listed below to compensate for specific operating or site conditions.

LOCATION	AVERAGE	MAINIAINED	FOOTCANDLES
Parking Lots			1-2
Platforms			2-5
Canopies			5-10
Station Buildings			5-10
Shelters			10
Stairs			5-10
Underpasses, Enclosed Overpasses			5-10
Sidewalks and Overpasses			5
Handicap Access Ramps/Parking			5-10

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B. OPTICAL CONSIDERATIONS

In the design of station building and site lighting, the contrast between various surfaces within eye contact should be maintained at ratios that will not reduce visual acuity, result in visual discomfort, or cause direct or reflected glare.

1. Contrast Ratios

The ideal contrast ratio between illuminated areas and adjacent or surrounding areas should be limited to 20:1. In no case should it exceed 80:1. The contrast between emphasis lighting and surrounding surfaces should not exceed a ratio of 3:1. The relative levels of luminance of signs and information panels to adjacent and background surfaces should not exceed a ratio of 5:1.

2. Glare

Luminaires should be designed and located to prevent the source's full brightness from being visible to the eye within normal viewing angle as shown in the accompanying illustration.

3. Reflected Glare

The angle of view of a vertical surface should exceed the angle at which light strikes the surface to avoid direct reflections from the source, as the accompanying diagram illustrates.

4. Methods of Control

Contrast ratios, glare, and reflected glare can be controlled through use of the following:

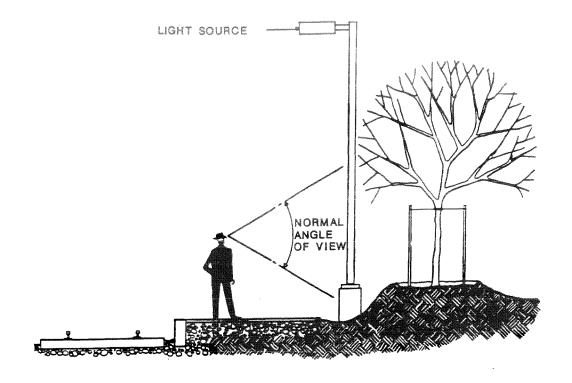
- Diffusers to moderate source brightness whenever possible.
- Indirect lighting, such as "wall washing" with light, to control glare and reduce the contrast ratio between a light source and the surrounding environment.
- Parabolic reflectors within light fixtures to control a light source without sacrificing light intensity on the lighted surface. They are especially useful with High Intensity Discharge (HID) lighting near residential neighborhoods.
- Contrast ratios and glare can also be controlled by adjusting the location and intensity of the source.

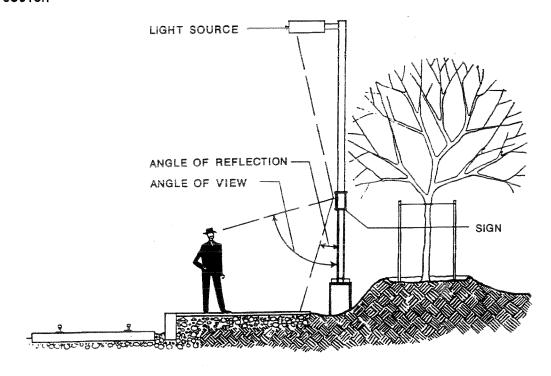
C. EMPHASIS OF HAZARDOUS AND TRANSITION AREAS

Higher levels of light should occur at potential danger or decision areas (stairs, track crossings, street crossings, platform edges, hidden corners, railings, and signage). This illumination should be at least 5-10 average maintained footcandles at the surface being lighted.

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Example of Method Minimizing Direct Glare





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D. EMERGENCY LIGHTING

Emergency lighting should be limited to the interior of enclosed station buildings and enclosed stairs. The system should have a self-contained battery pack and should be mounted at a height sufficient to prevent vandalism and to provide adequate emergency lighting with a minimum of fixtures.

IV. DESIGN CRITERIA AND DETAILS

A. GENERAL LUMINAIRES SELECTION CRITERIA

Luminaires used at commuter stations should meet the following criteria:

Function effectively for a minimum of 20 years.

 Resist vandalism, with polycarbonate or high impact acrylic diffusers and vandal-proof access devices such as latches, screws, and locks.

Minimize maintenance time and costs. Replacement of lamps and ballasts shall be easily accomplished. Lamps and ballasts shall be readily available and standardized to the greatest extent possible. All lenses, diffusers, access devices, and fasteners shall be of the captured type; hinged and removable to provide easy access and prevent loss or damage of parts.

Contain only non-corrosive materials.

- Function effectively within a -20 to + 110 F ambient temperature range (-28 C to +43 C).
- Provide fixture enclosure that keeps moisture and dust out, but allows heat to dissipate.

B. GENERAL LAMP SELECTION CRITERIA

- 1. A variety of lamp types is available today. Three factors should be considered in selecting the lamp type.
 - Lumen/watt efficiency of the lamp.
 - Effect of the light source color on the surface color appearance of the surrounding areas and objects.
 - Mounting flexibility.
- Due to the effect of light source color on surface color appearance, the result of lamp choice on user perception should be considered. A given lamp's lumen/watt efficiency and mounting flexibility should also be considered.
- 3. The lamp types available are:
 - a. High Intensity Discharge

High Intensity Discharge (HID) is the preferred light source for

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commuter rail stations because it is highly energy efficient. HID lamps are point light source, electric discharge lamps requiring ballasts. Starting requires several minutes. The preferred HID lamps are:

- Mercury vapor lamps, which emit a greenish-blue light and cause a perceptible shift in color rendition. They are highly efficient (30-65 lumens/watt) with long rated lives (16,000-24,000 hrs.) and excellent lumen maintenance. Mercury vapor lamps are primarily suited to high bay (over 13'-0" mounting height) applications.
- Metal halide lamps, which produce a white light. Color rendition is as least equal to mercury vapor. Metal halide lamps are smaller in size than mercury vapor lamps, yet produce a substantially greater output of lumens/watt.
- orange light and have a very perceptible effect on color rendition. High pressure sodium is the preferred HID lamp because it is the most efficient lamp currently available (approximately 100 lumens/watt). It should be used for lighting large exterior areas such as parking lots and walkways. A typical fixture that might be used in these applications is described in accompanying illustrations.

b. Fluorescent

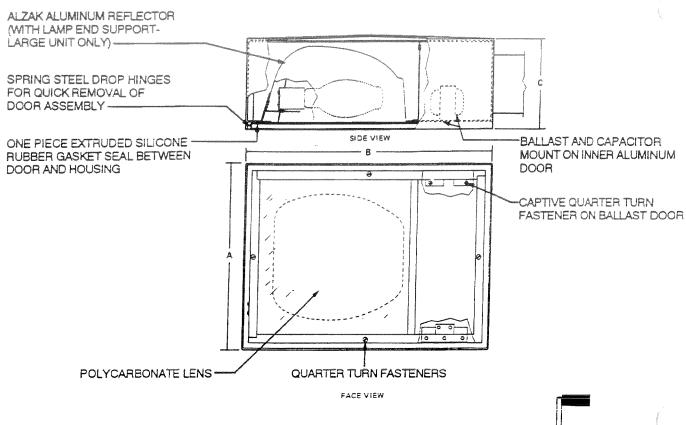
- Available in several colors. Warm white fluorescent lamps produce good color rendition and mix well with incandescent. Cool white lamps tend to dull warm colors and intensify cool colors, but are the most efficient (lumens/watt) fluorescent color. Fluorescent is a linear light source characterized by higher light efficiencies, cooler operating temperatures, and longer life expectancies than incandescent.
- Fluorescent lamps are effective in low and medium level lighting applications due to their efficiency and low source brightness. Fluorescent lamps are appropriate under most interior conditions and preferred over incandescent. They are recommended for lighting under canopies and shelters.

c. Incandescent

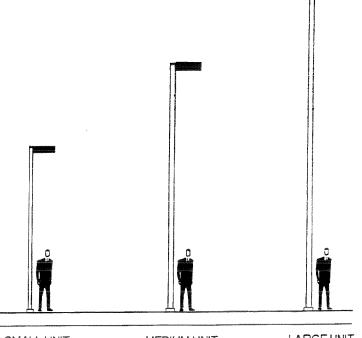
• Incandescent lamps are the least efficient light source (lumens/watt) and should not be used.

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Fixture Example



EXAMPLE OF FIXTURE APPROPRIATE FOR USE IN PLATFORM, PARKING LOT, AND WALKWAY AREAS: CROUSE-HINDS ASL SERIES OR EQUAL. RIGHT: TYPICAL MOUNTING HEIGHTS FOR FIXTURE OF THIS TYPE. 20'-0" TO 30'-0" POLE LENGTH IS TYPICAL AT COMMUTER RAIL STATIONS.



SMALL UNIT RECOMMENDED MOUNTING HEIGHT 10' - 25' MEDIUM UNIT RECOMMENDED MOUNTING HEIGHT 20' - 35' LARGE UNIT RECOMMENDED MOUNTING HEIGHT 25' - 40'



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C. WIRING

- 1. At all sites where regrading or resurfacing is planned, underground wiring shall be used. Underground wiring installed in Fiberglass Reinforced Epoxy (FRE) conduit sized in accordance with then Massachusetts Electrical Code (MEC) is preferred to overhead wiring for reasons of safety, reliability, lower long-term operating cost, and site appearance.
- 2. Wiring within canopies should be concealed whenever possible.
- 3. Any exposed wiring must be enclosed in conduit. The conduit should be installed in a manner consistent with the following criteria:
 - Follow architectural structural members, moldings, or ornamental details in as unobtrusive a manner as possible.
 - Match the color of the background on which it is mounted.
 - Resist vandalism with supports at intervals per the MEC within 9'-0" of ground level.

D. CONTROL COMPONENTS

- 1. Lighting control components at commuter rail stations include outdoor control centers and switches.
- 2. Outdoor control centers shall be provided at all stations. They shall be weatherproof and contain panelboards, lighting contactors, time clocks, and selector switches.
- 3. Recommended manufacturers of the control center enclosure are Hoffman Engineering Company, Lee Products Co., Russell L. Stroll, the Harry Richmond Company, or equal.
- 4. Control equipment utilized in commuter rail station lighting systems include:
 - a. Selector Switches

Selector switches provide control operation in three positions: Hands-Off- Automatic.

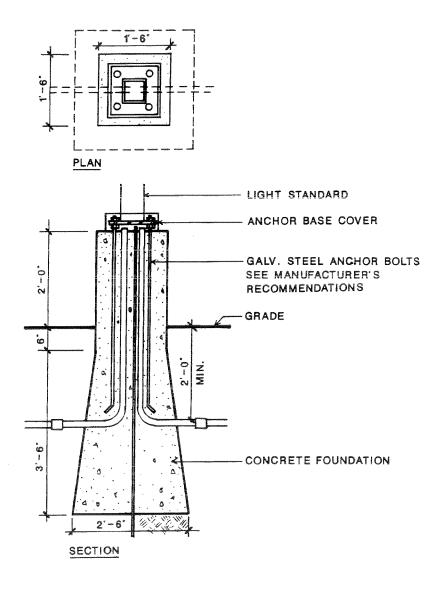
b. Photoelectric Sensors

Photoelectric sensors are fully automatic and provide illumination from dusk to dawn. Photoelectric switches are particularly applicable at locations where security and safety is a concern, such as shelters, station buildings, and track crossings.

c. Time Clocks

Time clocks shall be 24 hour and fully automatic and provide light at pre-set hours. Time clock components include such features as a seven day or astronomical dial, manual bypass lever, and sixteen-hour power reserve units. Time clocks are the most appropriate for parking area and platform lights that need not operate during the entire night. Time clocks shall be equipped with mechanically held contacts.

Typical Detail of a Pole Mounted Lighting Fixture Mounted on a 2'-0" High Concrete Pedestal for Protection from Vehicles



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E. FIXTURE MOUNTING AND LOCATION

- 1. The following general fixture mounting criteria apply to commuter rail stations:
 - Minimum clearance between the bottom face of the luminaire and ground level is 9'-0": the preferred minimum clearance is 11'-0".
 - ground level is 9'-0"; the preferred minimum clearance is 11'-0".

 Placement should be beyond the reach of persons standing on benches, trash receptacles, retaining walls, or other site furniture.
- 2. Criteria listed below apply to pole-mounted fixtures:
 - Fixture height: minimum of 9'-0" in pedestrian areas (platforms, walkways, etc.), 20'-0" minimum in vehicular areas such as parking lots and roadways; maximum of 30'-0".
 - Number of fixtures per pole: capable of receiving 1,2,3, or 4.
 - Location must be accessible for servicing by a bucket truck.
 - Poles shall be fixed, rather than hinged type base.
 - Do not use aluminum poles. Experience indicates that they break more readily than the steel pole.
 - Poles shall have handholes.
 - Fixture shall have individual cut-off optics.
 - Poles shall be mounted on a base extending a minimum of 2'-0" above finished grade at locations where poles are susceptible to damage by snowplows or other vehicles.
 - Shorter poles (20'-0" long) shall be able to resist damage from "whipping" and other acts of vandalism.
- 3. Typical pole-mounted fixtures which meet the above criteria include the Crouse Hinds ASL series, Sterner Lighting Systems (Model Type "Executive 25"), Gardco Lighting (Model Type "Form Ten EH"), or equal.
- 4. Fluorescent fixtures should meet the following criteria:
 - Be available in standard 4'-0" and 8'-0" lengths.
 - Provide single or double lamp capacity.
 - Have a 430 or 800 MA lamp capability.
 - Have a capability for use as a strip or individual fixture.

CHAPTER 4
GRAPHICS

I. INTRODUCTION

This section deals with the graphics requirements at commuter rail stations. As used in this manual, the term graphics refers to the full range of signs required to direct people to and within a commuter rail station site, warn of hazardous areas such as track crossings, and inform on matters of system use and operation. The format and appearance of the graphics described in this section are largely derived from the Authority's earlier graphics standards work; the MBTA Manual of Standards and Guidelines. Part V (1990 and subsequent revisions). These rapid transit system standards have been modified to meet the needs of more open and isolated commuter rail station environments.

II. DESIGN OBJECTIVES

User convenience, consistency, and durability are the principal design objectives of a commuter rail station graphics system.

A. USER CONVENIENCE

Graphics should be readily legible and should seek to minimize any uncertainty about train operation, present location, and destination.

B. CONSISTENCY

Graphics used at commuter rail stations should be consistent in appearance with those used on other lines operated by the Authority. This consistency contributes to the creation of a unified graphics system throughout the Authority.

C. DURABILITY

The various components of the graphics system— signs, sign frames, etc. should be fabricated from durable materials. They should be resistant to the effects of harsh weather conditions and vandalism and should require minimal long term maintenance.

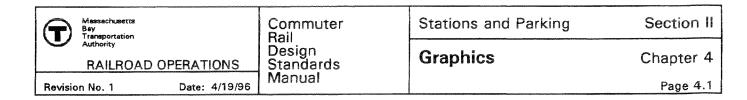
III. DESIGN GUIDELINES

A. TERMINOLOGY

1. This subsection deals with the standard terminology that shall be used at all commuter rail stations, as well as guidelines for the use of non-standard terminology, punctuation, and abbreviations.

2. Authority Name

In general, the full Authority name, Massachusetts Bay Transportation Authority, is not used at commuter rail stations. When used, however, it shall conform to formats presented later in this section.



3. Authority Symbol

The Authority's "T" symbol shall be used at all commuter rail stations to identify all entrances to the station site. At stations outside the Authority district, the "T" symbol shall be used in conjunction with the standard Trailblazer sign consisting of the "T", the words "Commuter Rail Station", and the standard directional arrow. The "T" shall also be located on the commuter rail system map panel and printed maps and schedules.

4. Platform Information

a: All stations with double or multiple track operations shall have the following destination information on the information band of the station identification signs:

Inbound:

"Inbound to Boston"

Outbound:

"Outbound"

b. All stations with single track operations shall have the following destination information on station identification signs:

Two lines using 1-1/2" text in the white band with a special arrow and text "Direction to Boston" and below it "Direction to xxxx" (outer terminal).

- c. Exceptions to the preceding guidelines are North Station and South Station where the terms "Inbound to Boston" and "Outbound" are deleted.
- d. Space permitting, additional local destination information may be placed in the information band of the station identification sign. Terminology should conform to the grammatical, punctuation, and abbreviation guidelines discussed below.
- e. At multi-track stations (island platform or 2 side platforms) provide track number/destination signs above the platform, at right angles to the track.

5. Other Standard Terminology

a. At stations where "live" parking, or a drop-off/pick-up area is provided, information directing the user to that area shall include the following terminology:

"Drop Off/Pick Up" and the international symbol of accessibility.

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- b. A warning sign with the phrase "Look Before Crossing" shall be located in front of all vehicular and pedestrian track crossings.
- c. A warning sign with the phrase " Danger Will Not Clear Man on Side of Car" shall be located at each end of high level platforms.

6. Grammatical Guidelines

- a. Terminology should be consistent in style and format with that used by the Authority outside the commuter rail system. Messages should be brief, avoiding unnecessary words and punctuation. Some examples follow.
 - "To" is normally not used with an arrow-circle unit, as in "To Exit", "To Platform", and "To Town Center". Exceptions to this rule are phrases such as "Exit to Mass. Ave." and "To Trains", which are used with the arrow-circle unit.
 - Avoid phrases such as "Left to Town Center". Use the arrow-circle unit in combination with the words "Town Center".

7. Punctuation Guidelines

- a. Minimize use of punctuation to be consistent with good grammatical form and clarity of meaning.
- b. Use the comma between items in a series and to separate two pieces of information. Example: "Town Center, Norwood Hospital".
- c. The period is used after an abbreviation and for the abbreviated versions of morning and evening. Example: "a.m.", and "p.m.".
- d. The hyphen is used to denote all joint names. Example: "Central Square-Lynn". While the hyphen is normally used between the words "Drop Off/Pick Up" sign presented later in this section.
- e. The ampersand is used in place of the word "and" when connecting two words which naturally belong together because of similarity of function or geographical proximity. Example: "Hamilton & Wenham".

In the case of unusual space constraints the ampersand may be substituted for the word "and".

8. Abbreviation Guidelines

a. Limit use of abbreviations to the most common and widely understood. Among those that may be used are:

"St."	street
"Ave."	avenue
"P1."	place
"Blvd."	boulevard
"Pkwy."	parkway
"Rte."	route
"N."	north
"S."	south
n E . n	east
"W."	west
"Ctr."	center
"Sq."	square

B. PICTOGRAPHS

- 1. Pictographs are graphic symbols that are used to convey a message in a more direct and readily recognizable manner than word signage. In the case of warning or prohibition signs (such as "No Smoking and "No Parking") the pictograph is often a more empathetic method of conveying the message than the words alone. Pictographs identifying accessible elements are to be accompanied by verbal description placed directly below the pictograph.
- 2. The standard pictographs to be used at commuter rail stations are based on the recommendations for a uniform pictographic vocabulary proposed by the American Institute of Graphic Arts to the U.S. Department of Transportation. The pictographs are described in more detail in the publication, Symbol Signs, DOTOS-40192, which may be ordered from: the National Technical Information Service, Springfield, VA 22151.

C. CARTOGRAPHY

1. The cartographic or map requirements at commuter rail stations are quite limited by comparison with those of rapid transit stations. Commuter rail station environments are generally quite open, thereby reducing the need for directions around the station and to destinations away from the stations. Two types of maps are potentially appropriate at commuter rail stations: the system map and the rapid transit line map.

2. System Map

The commuter rail system map is a diagrammatic representation of the entire commuter rail system that is consistent in format with the Authority's diagrammatic map of the rapid transit system. This map typically has three colors (purple, black, and white) and identifies connections with the Authority's rapid transit system. The purpose of

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this map is to provide users with general knowledge of the commuter rail service available and the system's connections to other Authority services.

3. Rapid Transit Line Map

> This map is provided at stations where there is a direct or nearby connection to the rapid transit system.

D. SIGN TYPES

Four types of signs are generally found at commuter rail stations: 1. identification, directional, regulatory/warning, and system use. A large share of the signs are in the identification and directional A general description of each sign type, as well as categories. location guidelines, is presented below. Sign layouts and methods of construction are described in Design Criteria.

Identification Signs 2.

- The two most common signs in this category are the System a. Identification Sign and the Station Identification Sign.
- b. System Identification Sign

Purpose: to identify the location of stations on the Authority's system.

consists of the Authority's "T" symbol 0 Description: mounted in a circular metal frame on a free-standing pole. It is similar in design to the "T" lollipop -shaped sign used at rapid transit stations, except the commuter rail version is not back-lighted. Illumination of this sign should be from adjacent, pole-mounted fixtures.

Location: at all major vehicular and pedestrian entrances Experience indicates that two system to the station. identification signs per station are normally sufficient.

Station Identification Sign C.

0 Purpose: to assist those disembarking from the train in identifying the station. Also to identify the platform necessary to direct passengers to local destinations.

Description: consists of a 9" high station name band and a 6" high information band typically mounted in a freestanding frame. The information band identifies the platform ("Inbound to Boston" or "Outbound"), and in some instances contains local destination information.

Location: along the back face of the platform parallel to the track(s). Preferred spacing of the signs is at 85'-0" intervals on each platform (one coach length). The minimum number of station identification signs at a station shall

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be one per platform. The signs should also be located adjacent to a platform light fixture for maximum visibility during evening hours. Avoid locating these signs directly across the tracks from a seating area to discourage vandals from sitting on the benches and throwing objects at the signs.

- d. Track Number /Destination Sign
 - Purpose: to identify the destination of the train located on the designated track.
 - Description: The track number and destination may be used in combination with the commuter rail combination sign panel. Refer to the MBTA Manual of Standards and Guidelines, Chapter 5 for more information.
- e. On-Site Identification Signs
 - A variety of on-site identification signs will typically be required in limited numbers. Among these are signs identifying accessible parking spaces, bus and drop-off zones, compact car spaces, space numbering and signage and taxi stands. With the exception of the required accessible parking signs, the number of these signs should be kept to an absolute minimum.
 - The locations of these signs are site specific. Signs identifying accessible parking spaces should be provided for each designated parking stall. These signs are normally pole-mounted, and care should be taken in locating the poles a minimum distance of 1'-0" from the outside face of a curb in areas where vehicles may be parked parallel to the curb; in areas of perpendicular parking, the minimum distance is 2'-6". "Compact Car Only" sign should be located at either end of the row of parking spaces with arrows pointing towards the center of the row. "Compact Car Only" signs without arrows should be located every 100 feet between these two signs.

3. Directional Signs

a. Included in this category of signs are off-site trailblazers, as well as signs providing directions around the station site. Directional signage should include signage to identify accessible routes between access platforms and parking areas and/or entrances and exits. Where the accessible route diverges from that used by the general public, an access symbol with directional arrow is required.

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b. Trailblazers

- Purpose: to direct potential users of the commuter rail system to stations and to improve access for drop-off/pickup vehicle drivers who are unsure of the station location.
- Description: consists of the "T" symbol, the words "Commuter Rail Station", and the Authority's standard directional arrow. It is pole-mounted.
- Location: typically along several major corridors to a station. Usually, all signs are within a several mile radius of the station and are placed at all key decision points. At stations outside the Authority district boundary, trailblazers are also mounted on the system identification sign at the station entrance since the "T" symbol alone may not be recognized in these areas.

c. On-Site Directional Signs

- o In addition to the directions that may be provided on the station identification signs, directional signs may also be required to direct motorists to drop-off/pick-up areas, bus drop-off/pick-up zones, remote accessible parking areas, the direction of major highway routes from the parking lot exit drive and the accessible route to the platform entrance, if it diverges from the general route to the platform entrance. Use of these signs should normally be limited to the larger, more complicated sites.
- These signs combine the standard pictographs with the directional arrow.
- Locations of the signs will vary with site conditions.
 Minimum curb clearances discussed earlier in this subsection should also be maintained with these signs.

4. Regulatory/Warning Signs

- a. Three types of signs in this category are generally used at commuter rail stations-"Look Before Crossing", "No Smoking", and "No Parking".
- b. "Look Before Crossing" Sign
 - Purpose: to alert motorists and pedestrians of any on-site railroad track crossing.
 - Description: a pole-mounted sign containing the phrase, "Look Before Crossing".
 - Location: at all vehicular and pedestrian approaches to a track crossing, including all main line tracks as well as freight sidings. Signs should be located a minimum of 8'-6" from the centerline of a single track; in double or multiple track locations, signs may be placed between

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tracks if a minimum clearance of 6'-9" to both track centerlines is maintained.

c. "No Parking "Signs

• Purpose: to identify areas on the station property where parking is not allowed.

• Description: consists of the standard pictograph mounted

on a pole.

Location: based on the needs of each station, but due to potential vandalism, the number of signs should be minimized. The 1'-0" and 2'-6" curb clearance criteria discussed previously in this subsection also apply to this sign.

d. "No Smoking" Sign

- Purpose: to inform users of the Commonwealth of Massachusetts law prohibiting smoking in Authority stations and vehicles.
- Description: a standard combination pictograph/written message sign provided by the Authority.
- Location: sign must be displayed in all enclosed waiting areas

5. System Use Signs

a. Current Authority policy is to provide two types of system use information at commuter rail stations. One is a diagrammatic map of the system, and the other is train schedule information.

b. System Map Panel

- Purpose: to inform commuters of all stations/locations served by the commuter rail system, as well as stations at which connections can be made to other service provided by the Authority.
- Description: a diagrammatic line map similar in format and design to the Authority "spider map" of the rapid transit system. It is typically presented on a 4'x 4' metal panel that is mounted on the station identification sign frame.
- Location: integrated into a station identification sign frame that is located at a central point on the inbound platform. Every station should have at least one system map, and some stations with higher ridership may warrant two maps, depending on the station layout. At least one system map panel must be located on the accessible route.

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c. Schedule Panel

- Purpose: to provide commuters routine information such as train schedules, notice of changes in service, fares, etc.
- Description: this type of information is subject to relatively frequent change. The approach used by the MBTA is to provide a combination sign panel that provides visual and tactile station identification, route maps, and schedules.
- Location: Provide at least one route map/schedule case combination along the accessible path to the platform. Refer to Part V, Graphics chapter of the MBTA Manual of Standards and Guidelines for more information.

IV. DESIGN CRITERIA AND DETAILS

A. GENERAL

- 1. The typography, symbols, arrows, pictographs, colors, and sign layouts described below are standards to be applied in the design of all signs for commuter rail stations. These standards are based on the Authority's Manual of Standards and Guidelines, Part V, Graphics.
- 2. The sign materials and methods of construction presented below are not standards, but are the product of the cumulative experience of the Authority with many previous sign design and fabrication contracts for both rapid transit and commuter rail stations.

B. TYPOGRAPHY

- 1. The standard Authority font is Helvetica and is illustrated on graphic pages following in this chapter. It is highly legible and available in all media: metal composition, photo-composition, wax transfer lettering, and vinyl adhesive-backed pre-cut letters. The standard weight used by the Authority is medium, and only capital letters shall be used on signs described in this manual.
- 2. Letter Size for Station Platform and Related Directional Signs:
 - a. Four letter sizes most generally used on the signs described in this manual -6", 4", 3" and 1-1/2".
 - b. 6" letters are used on station identification signs for:
 - Station name in the 9" color band.
 - c. 4" letters are used for:
 - Station name in the 6" color band.
 - d. 3" letters are used for:
 - All information in the 6" white band except as noted below.
 - e. 1-1/2" letters are used for:
 - Information in the 6" wide band where space is limited.
- 3. Letter size for site signing:

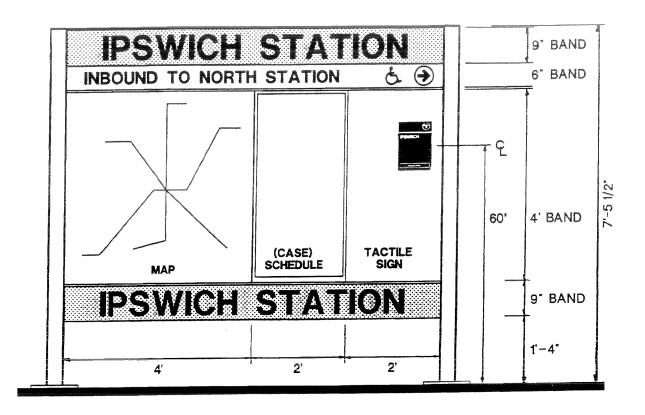
Size varies to suit available space and intended use. See sketches of typical standard signs.

4. Letter and Word Spacing

Letter and word spacing shall be in accordance with the rules established in Part V of the Authority's <u>Manual of Standards and Guidelines</u> and reproduced on the following pages. However, exceptions to this spacing are permitted in the case of space limitations. All exceptions must be approved by the Authority's Design Development Department.

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Commuter Rail Combination Sign Panel



Commuter rail combination sign panels provide required information for visual and tactile station identification, route maps and schedules. Sign bands may also contain information concerning track number, accessible route, etc. Provide at least one route map/schedule case combination along the accessible path to the platform. Where a raised access platform is located at a remote location from the main platform, provide this sign combination in both areas. Provide Tactile/Braille ID. sign in at least one central location along each platform.

Source: MBTA Manual of Standards and Guidelines, Chapter V.

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C. ACCESSIBLE FEATURES

1. General Requirements

Please refer to the Graphics chapter of the <u>MBTA Manual of Standards</u> and <u>Guidelines</u>, <u>Part V</u>, <u>Section Q</u> for detailed information about ADA regulations for MBTA signage.

- a. <u>Character Proportion:</u> The standard Helvetica Medium typeface used in MBTA signage should be used to comply with ADA specified width-to-height ratios.
- b. <u>Character Height:</u> Where signs are mounted suspended overhead, letter height must be a minimum of 3".
- c. <u>Finish and Contrast:</u> Characters should provide the maximum contrast with their background. White characters against a black background are the most legible. ADA requires that the characters and background should be of a non-glare finish, such as matte or eggshell. It is also helpful to have contrast between the sign and the wall in which it is posted on, and post the signs as frequently as possible.

2. ADA Sign Types

- a. <u>Tactile/Braille signs:</u> Required to identify permanent rooms, stations at entrances and platforms. The centerline of the sign must be 5'-0" A.F.F.
- b. <u>Station Identification Signs:</u> Consist of the typical MBTA sign bands system. ADA imposes certain requirements as to their location and frequency.
- c. <u>Directional Signs:</u> Provide information that riders need to use the system. Additional signs are required when 1) the accessible route diverges from the path of travel for the general public, or 2) when not all of a particular element are accessible.
- d. <u>Variable Message Signs:</u> If a public address system is used, ADA requires that a visual message system be provided for hearing impaired persons.
- e. <u>Miscellaneous Signs:</u> Other signs such as clocks, and accessible parking signs are regulated by ADA guidelines. Please refer to the Graphics chapter of the <u>MBTA Manual of Standards and Guidelines</u>, Revision 1995 for more detailed information.

D. SYMBOL, ARROW, AND PICTOGRAPHS

1. Authority "T" Symbol

The "T" symbol is typically 3'-3" in diameter when used on the system identification sign.

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2. Directional Arrow-Circle

- a. While its size will vary, the Authority's standard arrow-circle unit should conform to the following criteria:
 - The circle and arrow should always be used together and in the proportions established by the art work in the accompanying illustration.

• The height ratio of the arrow-circle unit to accompanying letters and numerals is 5:4, as illustrated on following pages.

 The arrow-circle unit may be used in any of the orientations presented on the following pages.

b. Train Direction Arrow

This arrow is detailed on the following pages. It is to be used preceding and following train direction information at stations with single track and island platforms.

3. Pictographs

- a. The pictographs described earlier are provided by the Authority for a fee to be determined.
- b. Pictographs should be sized to satisfy specific legibility requirements. Two commonly used pictographs the parking for the handicapped and no parking signs are illustrated with typical dimensions on following pages.

E. USE OF COLOR

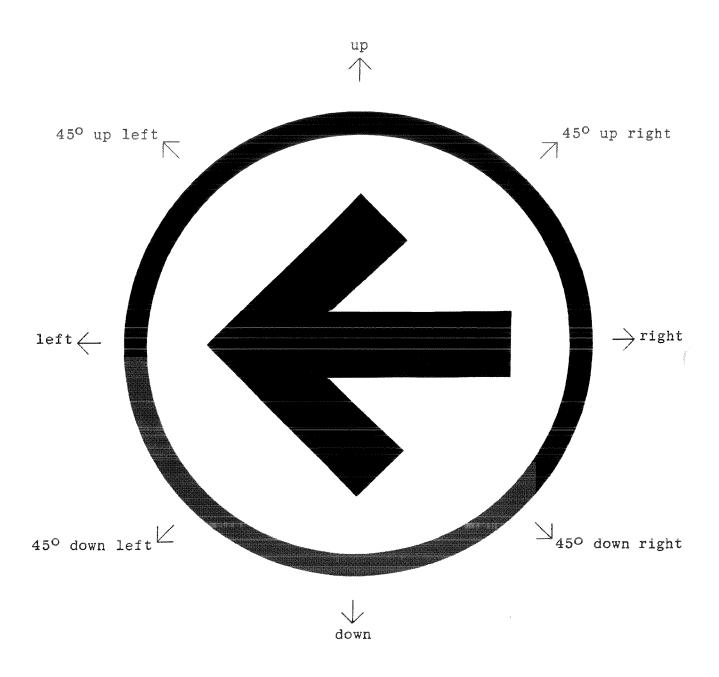
- 1. Criteria presented below concerning the use of color on commuter rail signs are based on the guidelines established in Part V of the <u>Authority's Manual of Guidelines and Standards</u>.
- 2. A maximum of five colors will normally be used for commuter rail station signs: black, white, purple, red, or yellow.
- 3. Black letters, symbols, and arrows on a white field (back-ground) are used to convey most directional and station identification information at a station. This standard is consistent with previous Authority standards and is also the most economical. Following are exceptions to the standard.

4. Purple

a. The standard color for commuter rail in the Authority's color-coding system is purple. Its application to commuter rail signs is similar in concept to the use of color on the rapid transit system signs. The purple color is used on the 9" high station name band and to identify commuter rail lines on the system map. In addition the color is used on the trailblazer signs as a field for the "T" s symbol and the words "Commuter Rail Station".

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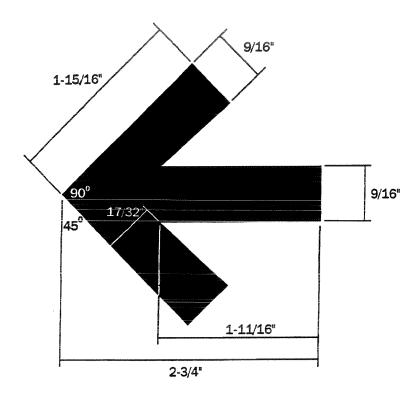
Arrow/Circle



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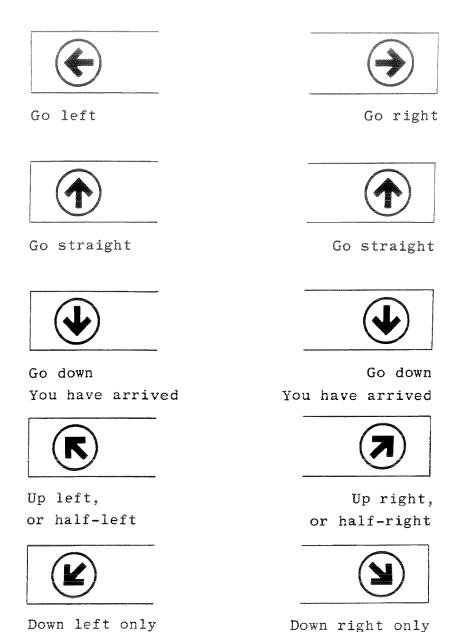
Train Direction Arrow

This arrow is to be used without a circle for indicating the direction of Inbound and Outbound trains for island platforms and single track stations.



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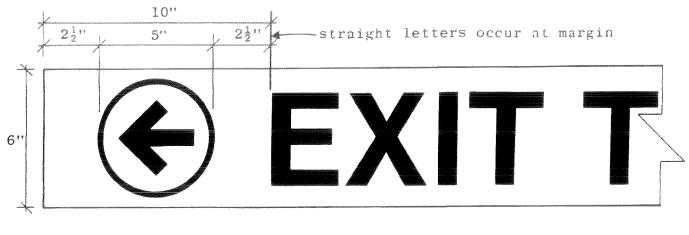
Arrow/Circle- Directional Conventions

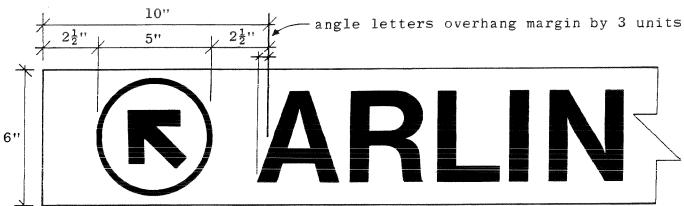


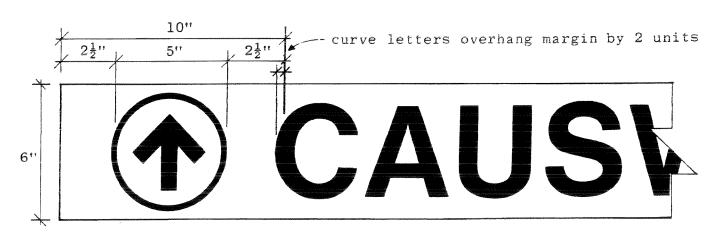
These are the proper attitude positions for the Arrow/Circle decal. Use the Arrow/Circle either left or right. Do not use on both sides of a sign unless one end or the other is obscured by a column, wall, etc. from some viewing positions. See following page for relationships to the edge of the sign and Section D of this chapter for use.

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Use of Arrow /Circle- Opaque Sign Bands



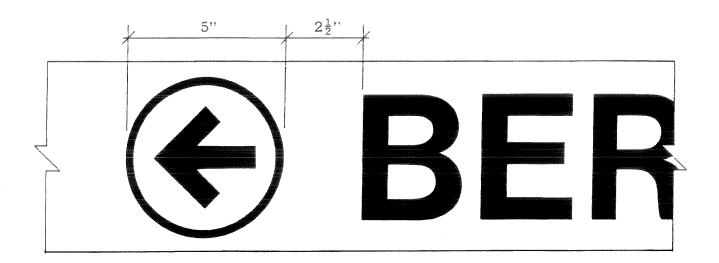




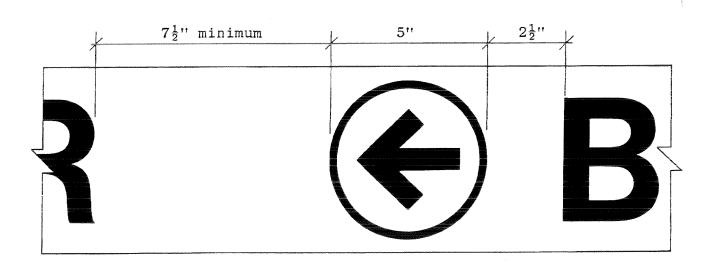
On a 6" signband, letters are 3" high and the arrow/Circle diameter is 5". The outside edge of the Arrow/Circle is 2 1/2" from left edge of signband and 2 1/2" from lettering margin. Spacing remains the same with the Arrow/Circle and lettering on the right side of signs.

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Use of Arrow /Circle- Continuous Opaque Sign Band



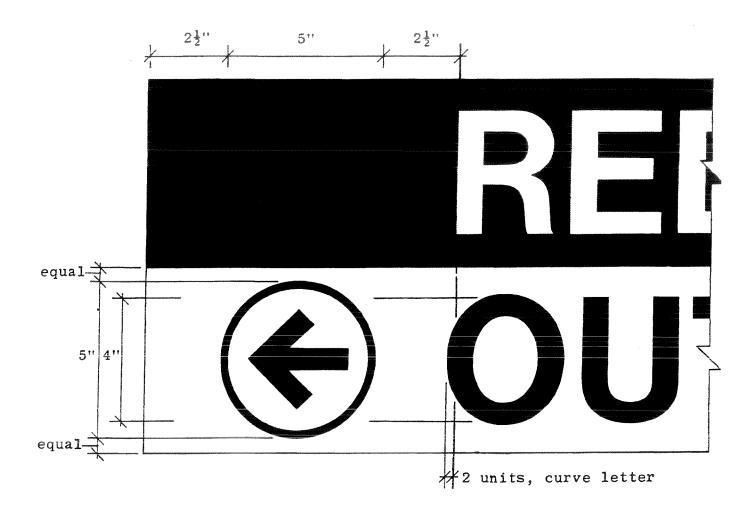
Single floating directional sign



Two adjacent directional signs

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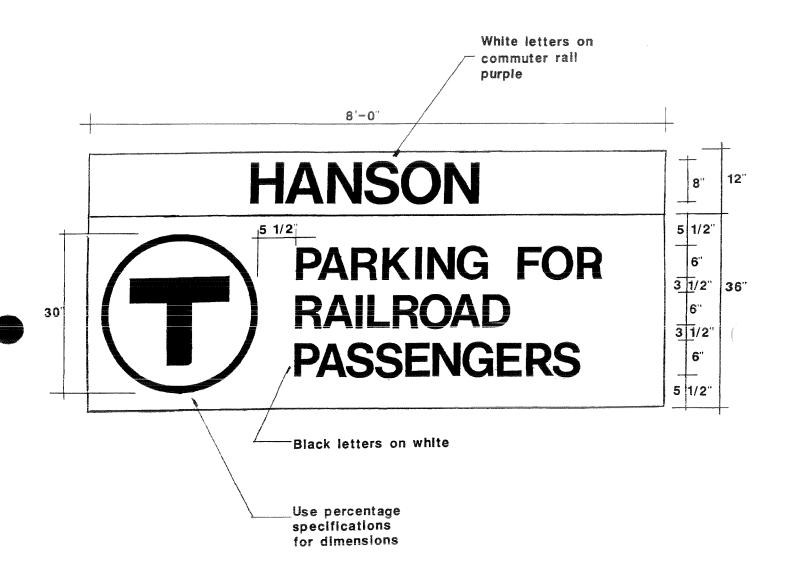
Use of Arrow /Circle- Line/Direction Signs



On signbands that provide information together, as a pair, the arrow must appear once, on the white band. $\,$

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Sign for Designated Parking for Railroad Passengers



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b. Commuter rail purple is specified using the Pantone Matching System (PMS) of offset printing inks developed by Pantone, Inc. Pantone Color Selector is available through art supply stores. The color number for commuter rail purple is PMS 241 (uncoated) and PMS 249 (coated). While experience indicates that this color may be difficult to match in certain applications, the designer should attempt to achieve the closest possible match in all uses of purple on the commuter rail system. See the accompanying chart for the Authority's standard color specification for purple in brush and spray paints.

5. Red

- a. The color red is used on regulatory/warning signs, especially the "No Parking" and "No Smoking" signs.
- b. Red should be as specified in the accompanying chart.

6. Yellow

- a. The color yellow is used on the vehicular/pedestrian track crossing warning sign, "Look Before Crossing".
- b. Yellow should be as specified in the complying chart.

7. Blue

a. The color blue is used for accessibility. The blue used for accessible parking space signs should match Pantone 300 (coated) and Pantone 293 (uncoated).

STANDARD COLORS

Pantone (printing Color	ink) <u>Uncoated</u>	Coated	Dupont (paints) Imron (spray)	<u>Dulux (brush)</u>
Red	485	485	58209UM	93-58209H
Blue	293	300	77257U	93-77257
Orange	144	152	60659UH	93-60659
Green	348	348	5316UH	93-5316
Purple	241	249	1976UM	93-6808
Yellow	123	123	6808U	
Silver	877	429	44400UH	
Dark Gray Light Gray White	a431 422	431 422	55322U 55137U 817U	93-55322 93-55322 93-21667
Beige	454	454	4480U	93-221667
Aqua	340	569	72218U	93-72218
Black	Black	Black	99U	93-005

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F. SIGN LAYOUT

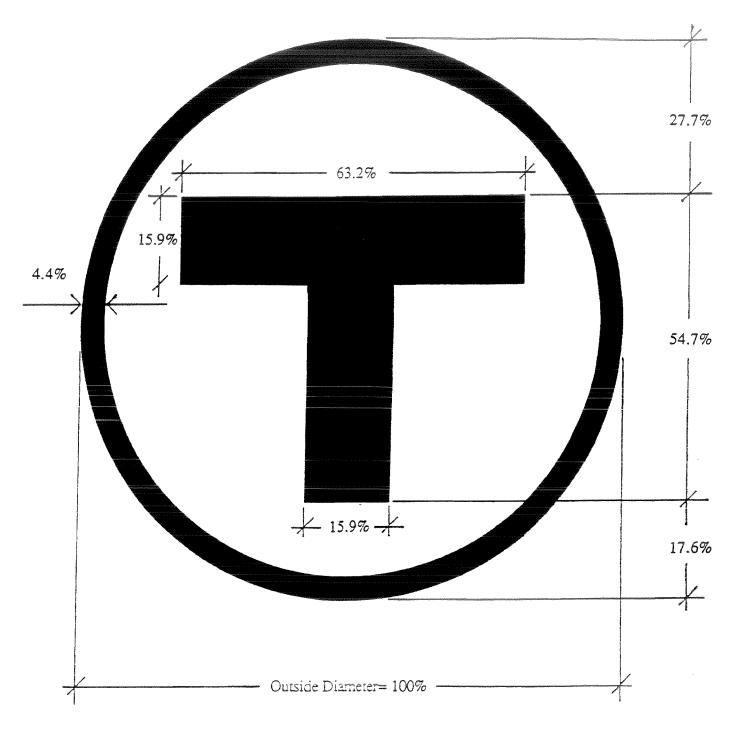
1. Sign Layout criteria generally are based on standards prescribed in the Authority's <u>Manual of Guidelines and Standards</u>. Part V. They are discussed below in terms of the four categories of signs.

2. Identification Signs

- a. The system identification sign, the "T" symbol, is laid out in accordance with the accompanying symbol art work except that the circle surrounding the "T" is omitted. This circle is replaced by the circular metal frame surrounding the "T".
- b. Station Identification Sign
 - The station name is on the purple colored band, which is typically 9"x 8'-0". The height of the letters (6") may be reduced if necessary to fit the station name within the 8'-0" panel.
 - o The platform identification "Inbound to Boston" and "Outbound To (Terminal Station or Stations)" is centered on the white portion of the band (6"x 8'-0") with 3" text in double or multiple platform conditions. See the accompanying illustrations for examples of this layout.
 - For single track and island platform conditions, the 6" information band contains "Direction to Boston" in 1-1/2" text over the text "Direction To (name of terminal station or stations)" in 1-1/2" text. Both lines of directional text are either preceded or followed by a special train direction arrow detailed in the preceding pages. The information is left or right-justified in accordance with the following illustration.
 - The margins between the arrow-circle unit, the borders of the panel, and adjacent words are standards to be maintained with other information presented on the panel.
 - $^{\circ}$ Local destination information may be incorporated into the 6" information panel along with the platform identification. Where space is limited, 2 lines of 1-1/2" text may be used.
 - Messages (platform identification and local destinations) must be separated.
 - Letter size must be the same for each message.
 - Letter size may be reduced below the standard 4" height when additional space is required. The circle-arrow unit must also be reduced in size proportionally to maintain the same 5:4 ratio of outside circle diameter to letter height.
 - Provide an arrow-circle unit for messages in a single platform condition.

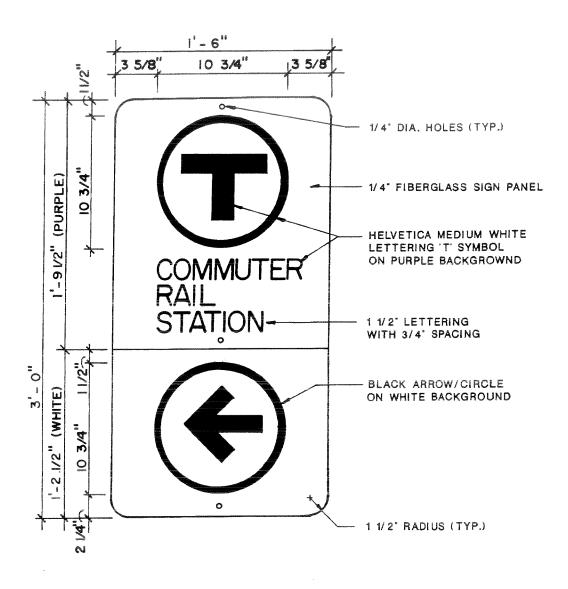
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Symbol, Diameter Larger Than 4"



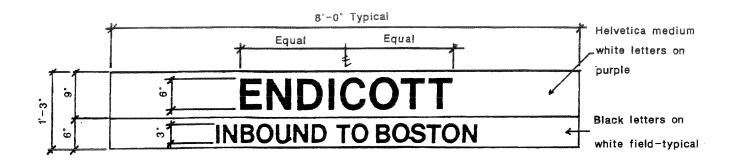
• Logo Proportions example: for 20" diameter, $20 \times 54.7\% = 10.94$ " high T

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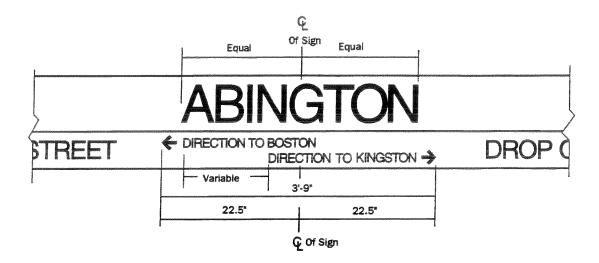
Destination Information, Double or Multiple Track Station with Side Platforms. (Assume right hand direction of trains)



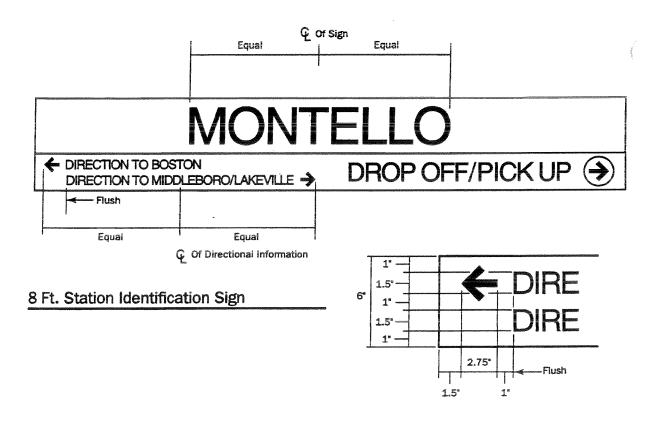
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Island Platform and Single Track Destination Information

These designs should be used for island platforms with multiple tracks or for single track stations where trains heading inbound and outbound make use of the same track.

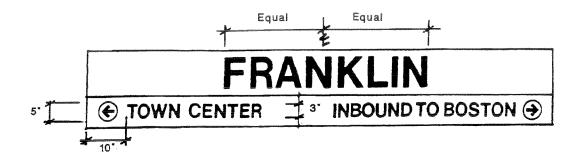


12 Ft. Station Identification Sign



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Example of Standard Method for Inserting Local Destination Information on Station Identification Sign



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c. Other Identification Signs

The other most commonly used identification sign is the pictograph used to identify parking spaces for the handicapped. The standardization of pictograph sign sizes is not appropriate, but a convenient size used in the past consists of a maximum image area dimension of 10 3/4" on a 1'-2"x 1'-2" sheet metal field (see accompanying illustration).

3. Directional Signs

- a. The trailblazer sign is a commonly available size of sheet aluminum: 1'-6"x 3'-0" and is Authority standard in terms of letter and symbol size, color, and layout. The standard sign is described in the accompanying illustration.
- b. Other directional signs, such as those directing the motorist to drop-off/pick- up areas and additional parking, will vary in size with site conditions. The relationship of the arrow-circle unit to the message unit (e.g., the "P" symbol or "Drop Off/Pick Up") should be in accordance with the examples presented in the accompanying illustration.
- c. All copy on directional signs located away from the platform should be left-justified.

4. Regulatory/Warning Signs

- a. The "No Parking" pictograph sign should be designed in accordance with the pictograph layout criteria presented above.
- b. The vehicular/pedestrian track crossing sign must conform to the standard illustration on the following page. For this sign only, the words are stacked and centered rather than left-justified.

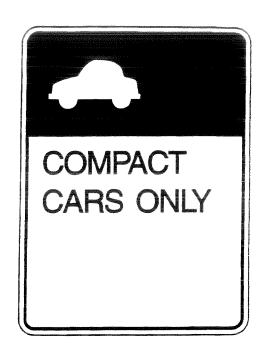
5. System Use

- a. The system map is a standard size. Camera ready art work for these maps is provided by the Authority for a fee of \$1,000.00.
- b. The information panel is typically a white panel of the same size as the system map panel-4'x 4'.

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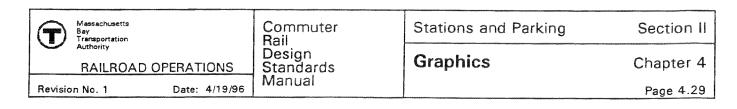
Standard On-Site Identifications Signs (Pictographs)



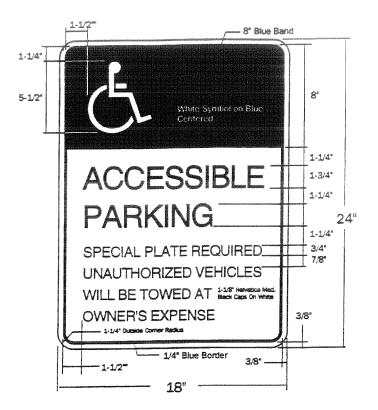






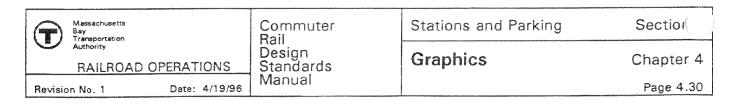


Standard On-Site Identifications Signs (Pictographs)



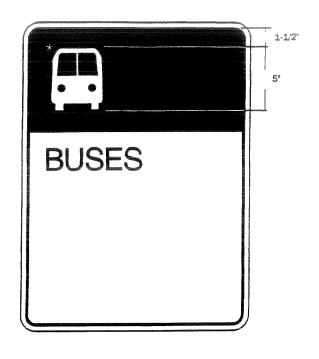




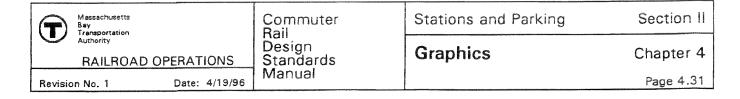


Standard On-Site Identifications Signs (Pictographs)



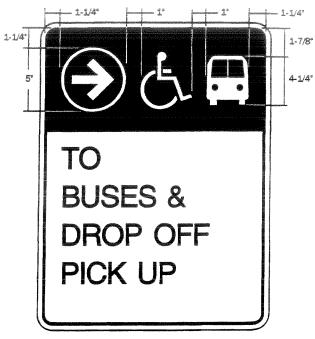


These signs should be located at either end of the bus and drop off/ pick up zones.



Examples of On-Site Directional Signs

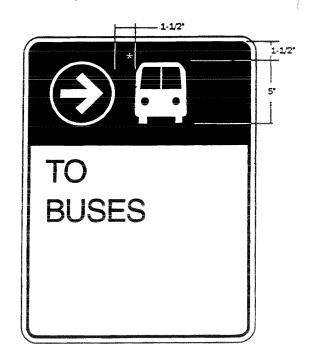




These signs are to used en-route to the various facilities, and up to the platform entrance locations.

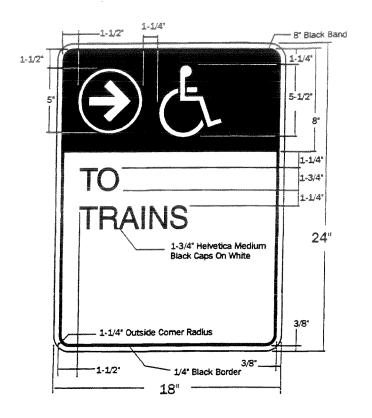
These signs are not to be used within platform areas.





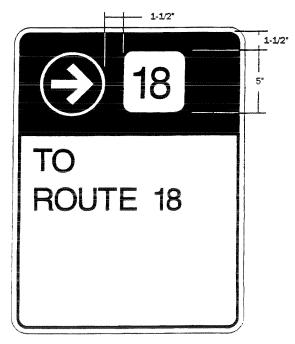
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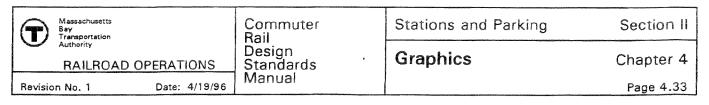
Examples of On-Site Directional Signs



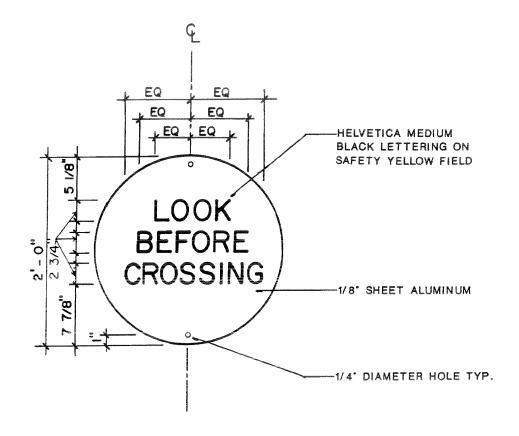
TO COMMUTER PARKING

These signs are to be used en-route to the various facilities, and up to the platform entrance locations. These signs are not to be used within platform areas.





Standard Vehicular/Pedestrian Track Crossing Sign



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G. SIGN MATERIALS AND METHODS OF CONSTRUCTION

1. Fiberglass

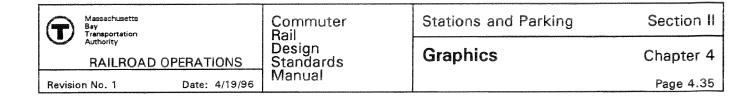
- a. All platform and related directional signs, plus the station name sign at the entry to parking lots are 1/4" fiberglass, bonded to 3/4" aluminum channel stiffeners. Refer to "Manual of Guidelines and Standards, Part V" for more detailed information on fiberglass sign material specifications.
- b. The "T" symbol uses 1/4" flat sheet fiberglass over a plywood backing. Trailblazers are 1/8" fiberglass.
- c. All other site miscellaneous small signs are to highway standards— plastic film laminated on 1/8" aluminum.
- d. At locations where the fiberglass sign frame is susceptible to vehicle or snowplow damage, mount the frame on reinforced concrete pedestals, as illustrated in the accompanying detail.

2. Sheet Aluminum

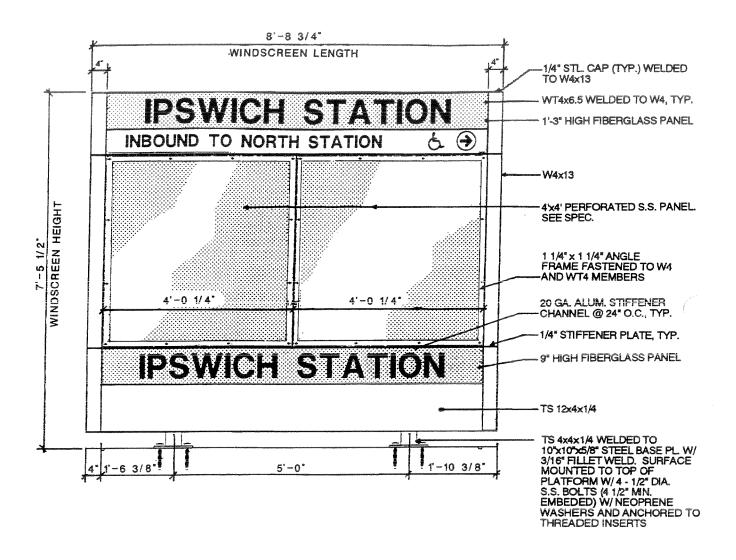
- a. Sheet aluminum of a 0.125" thickness is typically used for all other commuter rail station signs. Typical fabrication and installation details for system identification sign are illustrated on following pages.
- b. The standard mounting detail for all other sheet aluminum sizes is the Massachusetts Department of Public Works P-5 break-away post assembly, specified as galvanized. (See the accompanying detail).
- c. Minimum clearance between the lower face of the circular frame of the system identification sign and grade is 12'-0".
- d. Minimum clearance between all other sheet aluminum signs and grade is 7'-0", a Massachusetts Department of Public Works standard.

Galvanized Steel

a. Galvanized steel used in sign frames may be finished with shop applied paint within 12 hours of galvanizing.

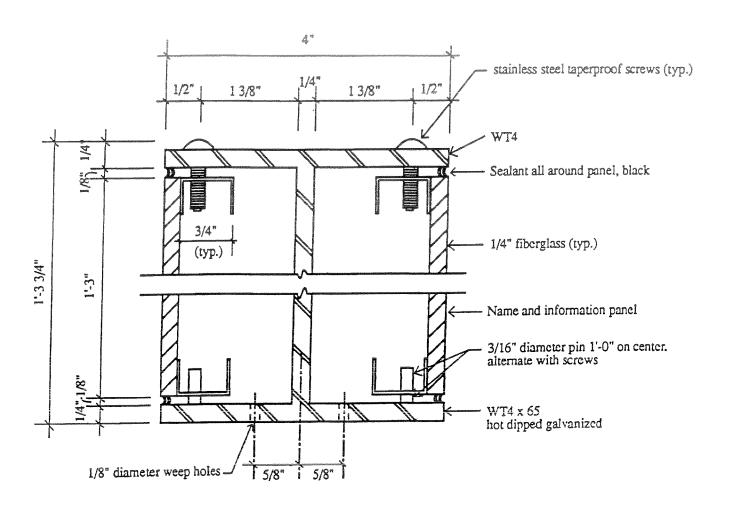


Typical Construction Details for the Station Identification Sign



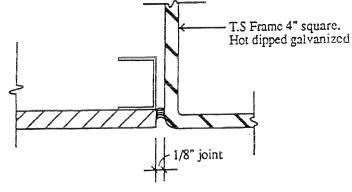
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Typical Construction Details for the Station Identification Sign



• Typical Commuter Rail Sign section with Name & Information Band - Fiberglass Sign Panels

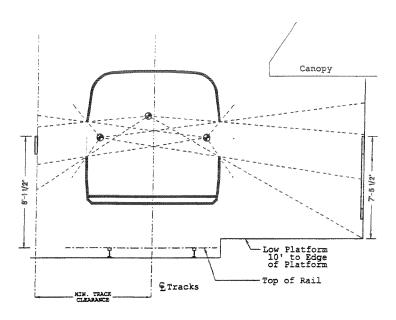
scale: 3/4" = 1"



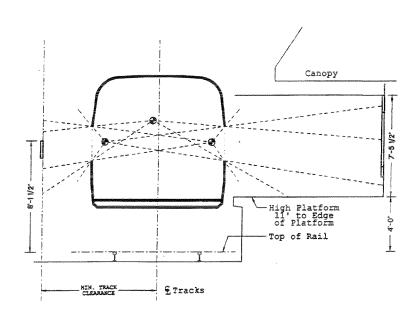
Vertical Joint at Edge of Sign

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Station Identification Sign Heights



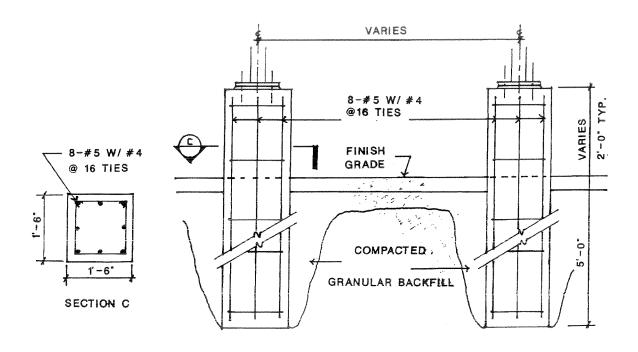
Viewing Angles for Single Height Rail Car at Low Platform



Viewing Angles for Single Height Rail Car at High Platform

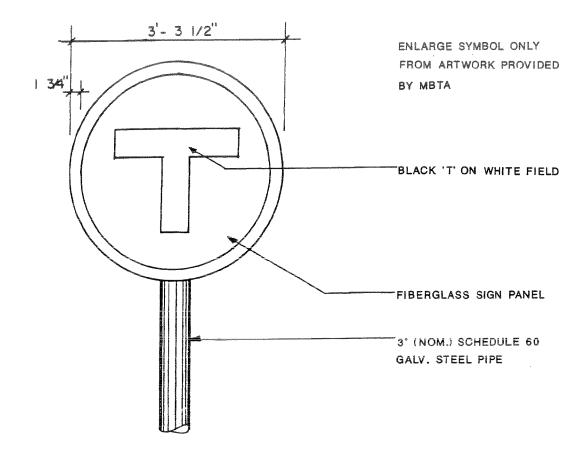
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Typical Construction Details for Concrete Pedestals Used with Pedestal- Mounted Station Identification Sign



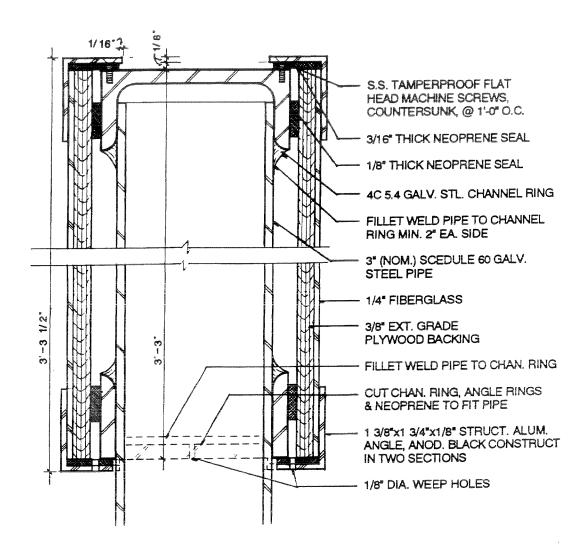
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Typical Construction Details for System Identification Sign



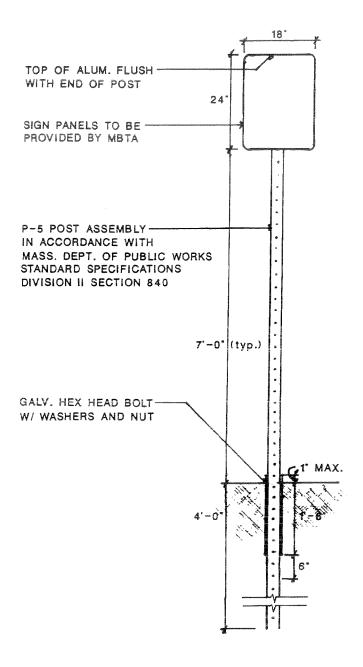
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Typical Construction Details for System Identification Sign



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Standard Mounting Details for Sheet Aluminum Signs



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I. INTRODUCTION

This section deals with the types of user comforts and conveniences that should be incorporated into commuter rail stations, such as seating, telephones, and concessions. These facilities, when integrated into the design, make the station more comfortable and convenient.

II. DESIGN OBJECTIVES

A. COMFORT

Provide facilities that increase the user's comfort while waiting for the train, consistent with the objectives of minimizing targets of vandalism and achieving economy of design.

B. CONVENIENCE

Provide facilities that make the station more convenient to use by consolidating activities that might otherwise require several trips (buying a newspaper, making a phone call, etc.) in one location.

III. DESIGN GUIDELINES

A. GENERAL

Six types of facilities are discussed in this section: seating, telephones, trash receptacles, vending machines and concessions, clocks, and toilet facilities. Some of these facilities should only be included at the most heavily used stations.

At low platform stations with an access platform, platform amenities (seating, etc.) must also be provided on the access platform.

B. SEATING

- Seating should be provided at all stations and designed to provide maximum:
 - Physical comfort
 - Capacity
 - Freedom of choice
 - Durability under exposure to extreme weather conditions and severe vandalism.

2. Capacity Guidelines

a. The amount of seating required at a station will vary with the shape and size of the site and surrounding facilities. Seating requirements are best established through observation of how other stations are currently used rather than basing the need on

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overall or peak period ridership. The designer should seek to identify the extent to which people use adjacent facilities, such as restaurants, taxi stands, and their cars when waiting for the train.

b. The quantity of seating should also be based on observations of sitting patterns, including the spacing people maintain for psychological comfort. Studies indicate that typically 28 people are seated per 100 linear feet of sitting space.

3. Location Guidelines

- a. Seating should be located where the user will have easy and direct access to the platform. The user should also have a direct view of approaching trains from the seating.
- b. Avoid locating seating across the tracks from sign units to discourage vandals from throwing objects at the signs while sitting at the station.
- c. Seating should be highly visible from surrounding activities and in a well lighted area for night time use.
- d. Avoid locating seating in areas that will impede pedestrian traffic flow.
- e. Seating should be in a covered location if possible.
- f. Do not locate seating where it may prevent direct approach to signs by users with limited vision.
- g. Seating must conform to AAB requirements to be located at intervals along platforms to not exceed 200 feet.

C. TELEPHONES

- 1. A public telephone should be readily accessible at all commuter rail stations, either on site or immediately adjacent to the site.
- 2. Telephones should be located:
 - Under shelter or cover where possible
 - In highly visible (from the station and surrounding area) and heavily traveled areas
 - Where users can view an approaching train
 - Where they do not impede or obstruct pedestrian traffic
 - In areas and at mounting heights accessible to the handicapped
- 3. Where interior public or banks of (two or more in a single location) telephones are provided, at least one should be TTY equipped. It must be identified with the TTY symbol.

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D. TRASH RECEPTACLES

- Trash receptacles should be installed at all commuter rail stations, 1. but only if the Authority has negotiated an agreement for the periodic pick-up of trash and maintenance of the receptacles.
- 2. The receptacles should be located:
 - In heavily used areas
 - Where they do not impede pedestrian traffic 0
 - At points that are accessible to pick-up crews

VENDING MACHINES AND CONCESSIONS E.

- Currently, the Authority does not install or maintain vending machines ţ. or concessions at commuter rail stations. In certain instances, the Authority encourages businesses to lease unused space and provide concessions oriented to users of the system. The following guidelines identify some of the more appropriate types of vending machine services and concessions that might be provided at commuter rail stations, as well as the appropriate locations for these facilities.
- The types of vending machine services that are most appropriate at a 2. station include:

Newspapers

Snacks-candy, pastries, etc.

Soda

Coffee

Stamps

With the exception of newspapers, these vending services are generally provided in an enclosed building and are under continuous surveillance by the operator or user of the services. Some of the services also require electricity, plumbing, and heat. Accordingly, vending services other than newspapers should be provided only at those stations with enclosed buildings and that are manned by a ticket agent or a concessionaire.

Among the concessions appropriate to a commuter rail station are: 3.

Diners and restaurants

Taxi stands Gift shops Book stores

Florist shops Real estate offices Travel agencies Laundry/dry cleaners

Concessions such as these will require an enclosed building. They are generally feasible only when the station has high ridership or is located in an area that has high visibility and traffic volumes.

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- 4. The need for vending machines and concessions should be evaluated on the basis of the availability of these facilities in the vicinity of the station.
- 5. Vending machines and concessions should be located in areas that are:
 - Readily accessible to waiting areas and pedestrian walkways along an accessible route.
 - Easily observed by the station agent (in the case of most vending machine services) or from the surrounding community (in the case of newspaper vending machines.)
- 6. The facilities should also be located where they do not obstruct views of the platform and approaching trains or impede pedestrian flow.

F. CLOCKS

Clocks should be provided at all stations with enclosed waiting areas. They should be located where they are readily visible from all parts of the waiting area and conform to ADA standards.

G. TOILET FACILITIES

- 1. All manned stations shall have toilet facilities, and at the discretion of the station agent, may be made available to commuter rail passengers. All toilet facilities must comply with the <u>Americans with Disabilities Act Accessibility Guidelines</u>. Toilet facilities open to the public must also comply with the <u>Rules and Regulations of the Architectural Access Board</u> of the Commonwealth of Massachusetts.
- 2. Toilet facilities shall conform to all building code requirements. Fixtures and accessories required include:

1 sink 1 tissue dispenser
1 toilet 1 trash receptacle
1 mirror with shelf 1 electrical outlet 1 soap dispenser

3. The preferred location for toilet rooms in station buildings is adjacent to the main waiting room with access doors directly observable from the agent's office.

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IV. DESIGN CRITERIA AND DETAILS

A. SEATING

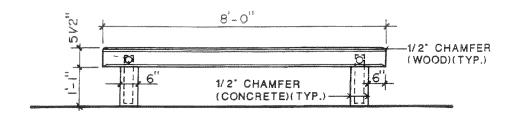
- 1. Seating at a station can take many forms, but should meet the following dimensional criteria:
 - A continuous bench style, at least 7'-6" long, to allow for maximum freedom of choice.
 - A minimum of 16" and maximum of 20" high
 - A minimum of 15" in depth
 - A minimum 3" heel space for ease of rising from a seated position.
 - o To facilitate sitting and rising for people with limited strength and flexibility it is recommended that at least half of the fixed benches at each site have a high back and armrests.
- 2. The seating should be designed to require a minimum number of vertical supports, thereby reducing the potential for litter collection beneath the seating.
- 3. Seats should be slatted and sloped from front to back for rain and snow drainage.
- 4. Seating materials must be highly durable and vandal-resistant, but non abrasive to human contact.
- 5. Avoid the use of materials such as the extruded aluminum benches found in prefabricated bus shelters and wood of 2" nominal thickness or smaller since they are highly susceptible to vandal damage.

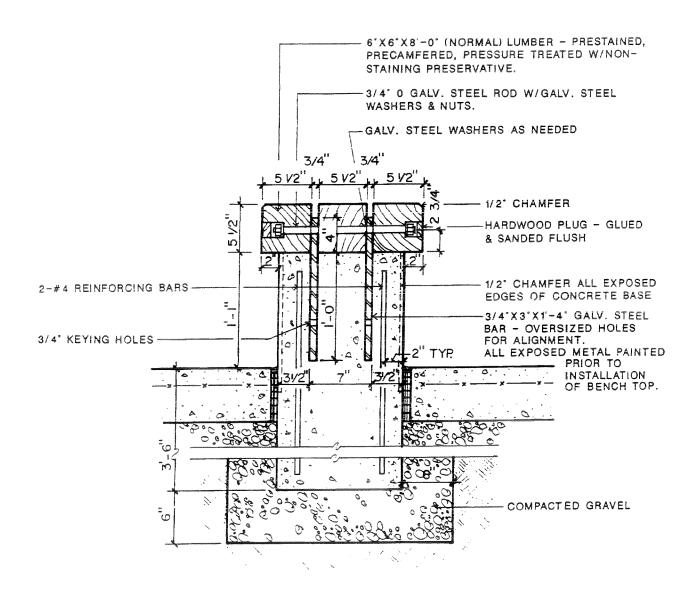
B. TELEPHONES

- 1. Public telephone installations must include at least one telephone per bank (two or more in a single location) that is accessible to people who use wheelchairs, as required by the <u>Rules and Regulations of the AAB</u> and <u>ADAAG</u>. In addition, 25% of the telephones per bank, but never less than one, must have a volume control.
- 2. Among the other features which each telephone installation should contain are:
 - Posted numbers listing emergency numbers (police, fire, etc.) and convenience numbers (Authority number for information on service, delays, etc., and local taxis).
 - A telephone directory, attached to the installation and protected from the weather.
 - Lighting to read the dial and directory.
 - A shelf for personal articles such as gloves, purse, change, etc.
 - o TTY

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Typical Bench Construction Details





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C. TRASH RECEPTACLES

- Trash receptacles should follow the MBTA Commuter Rail standard with 1. locking tops. Refer to previous construction jobs for specifications. They should also have the following features:
 - Large opening for easy trash disposal
 - 0 Minimal exposure of opening to rain and wind
 - High (55 gallon) capacity, self-draining container
 - Durable material, resistant to the abuse of weather and vandalism
 - Capability for being affixed to an object such as a utility pole or located within a heavy, immovable container (precast concrete, etc.)

D. TOILET FACILITIES

- Fixtures: all urinals, and sinks shall be wall-hung vitreous china. 1. Fittings should be either stainless steel or chrome-plated brass with concealed or vandal-proof anchors.
- 2. Accessories: compartment partitions and fittings should be stainless steel. Mirrors should be plate glass with stainless steel frames. All other accessories should be of stainless steel construction with concealed and tamper-proof mounting devices.
- should be rugged, chemical- resistant, and easily 3. Room finishes: cleaned.
- 4. provide lighting to achieve an average level of 30 footcandles. Switch should be provided so that the lights are in operation only when the facilities are in use.
- Ventilation: provide mechanical ventilation to the outdoors with make-5. up air supply from either louvers or undercuts at the toilet room access doors.
- 6. Floor drains and wash down facilities should be included where possible.

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CHAPTER 6
LANDSCAPING

I. INTRODUCTION

This section deals with landscaping of the station site. As used in this manual, the term landscaping refers to the existing natural features of a station, as well as additional natural (trees, shrubs, ground cover, etc.) and man-made (fencing, special paving materials, etc.) elements that can be used to enhance the overall visual quality of a station. Proper use of existing station landscaping, when combined with the selective use of new landscape elements, can also help make the site compatible with the surrounding area.

II. DESIGN OBJECTIVES

The principal objectives of the site landscaping are increased attractiveness, user safety and security, preservation of significant existing features, durability/maintainability of the landscape elements, and soil conservation.

A. ATTRACTIVENESS

Provide an attractive station environment by using landscaping to 'soften' the effect of large paved areas, integrate the station into compatible surrounding areas, and buffer the station from incompatible surroundings.

B. SAFETY AND SECURITY

Use landscaping elements to improve the safety of pedestrian and vehicular movements and to maximize surveillance of the station (and enhance user security) from the surrounding area. Note that enhancing security through increased station visibility from the surrounding area may conflict with requirements to buffer the site from incompatible surroundings.

C. PRESERVATION

Preserve and capitalize on existing site assets such as trees, water, views, or historic buildings.

D. DURABILITY/ MAINTAINABILITY

Use landscaping suited to the climate, resistant to vandalism, and low in maintenance requirements.

E. SOIL CONSERVATION

Provide adequate storm water drainage facilities that minimize uncontrolled water run-off and minimize soil erosion on and off site.

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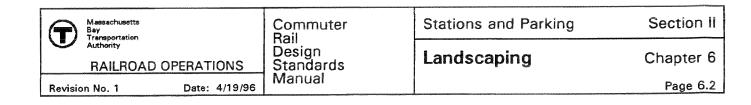
III. DESIGN GUIDELINES

A. GENERAL

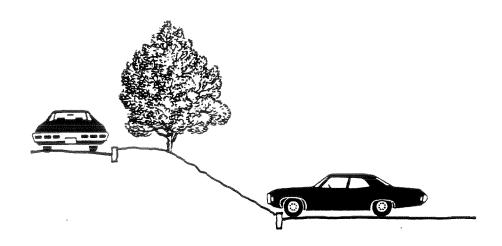
Three areas of concern addressed in this section are: buffers, site drainage and planting. Site improvements in each of these categories may contribute to the achievement of the attractiveness, safety, security, preservation, and soil conservation objectives. All of the design guidelines pertaining to each of the categories are aimed at satisfying the fifth objective-durability and maintainability of the site improvements.

B. BUFFERS

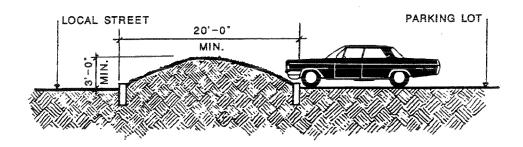
- 1. Buffers include various types of natural and man-made devices that can be used to visually screen incompatible land uses (such as a station parking lot from adjacent residences) or to attenuate the noise emanating from trains.
- 2. Among the visual screening devices that may be used are:
 - a. Site topography: at some stations it may be possible to use substantial grade changes on the site to visually screen parking from the surrounding area. However, it is necessary to maintain the visibility of the parking lot at all times, in order to increase the feeling of security and discourage vandalism and crime.
 - b. Earth berms: where a relatively level site does not permit the use of site topography, earth berms, as illustrated on the following page, may be used as a screening device. They are generally a minimum of 3'-0" high and require a minimum of 20'-0" horizontal distance to achieve proper slope ratios for the minimum height berm. They are typically planted with a low maintenance ground cover, described later in this section.
 - c. Planting: sticker-bushes, hedgerows, and trees may be used as a partial visual screen. The general effect of planting will be to lessen the visual impact of the station on the adjacent area, rather than to create a complete blockage of sight lines between the station and the surrounding area. Maintaining at least partial station visibility from the surrounding area is important to enhancing personal security at the station. Appropriate plant materials are described later in this section.
 - d. Fencing: another means of visual screening is accomplished through the use of fencing. Opaque fencing material solid wood fencing and masonry walls are examples is typically very expensive and difficult to maintain. Consequently, the use of fencing as a screening device is not recommended at commuter rail stations and should be used only when the other three approaches are found to be unsuitable to a site.



Site Topography as a Screening Device



Berms as a Screening Device



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- 3. The Federal Environmental Protection Agency has formulated standards for the noise levels of railroad rolling stock. The proposed standards are 88dBA for rolling stock operating at up to a 72 kph (45 mph) and 93 dBA for speeds greater than 72 mph, as measured at a distance of 30 meters (100'-0").
- 4. Two approaches to alleviating noise impacts are described below:
 - a. Berms and walls: a high percentage of rail right-of -way noise is generated at track level. Earth berms or walls located immediately adjacent to the tracks will partially deflect or absorb this noise and reduce noise levels on abutting properties.
 - b. Visual screening: in some instances it has been noted that a major component of the noise problem is the result of a psychological rather than a physiological reaction to the noise-i.e., viewing the source of the noise becomes a disproportionately large part of the problem. In these cases, it may be possible to mitigate the impact through the use of densely planted shrubs and trees, especially evergreens. Note, however, that these materials do little to alleviate the noise.

Location Guidelines

- a. The location of visual screening devices will, of course, vary with the site. In general, however, they should be located at the perimeter of the site.
- b. Maintain a 10'-0" distance between walkways, platforms, and parking areas and new or existing dense vegetation.
- c. Locate buffers in a manner that insures undisturbed visibility at all pedestrian and vehicular intersections.
- d. Select tree species whose lowest branch height is 7'-0" or greater.
- e. Insure that the landscaping does not reduce the effectiveness of the site lighting.
- f. Avoid screening the platform waiting areas from the surrounding neighborhood and streets.

C. SITE DRAINAGE

- 1. As used in this chapter of the manual, the term site drainage refers to actions required to manage storm water in both paved and unpaved areas of a station site. Stations should have storm drainage systems that connect to municipal systems. Much of the storm water flows to existing street catch basins or is simply absorbed by the soil on-site. All plans for upgrading a station drainage system must be coordinated with local public works departments and conservation commissions.
- 2. Station improvements, especially parking, create a substantial increase in paved area and may also disrupt natural drainage patterns. The following guidelines establish a preferred approach to dealing with the issues of grade modifications, drainage of paved areas and unpaved areas, and slope control.
- 3. Grade Modification Guidelines
 - a. The grading design should balance the aesthetic, drainage, maintenance, and operational needs of the station site.
 - b. Coordinate proposed grades with plant material to remain (such as larger trees) and with other existing site elements.
 - c. The grading design should attempt to balance cut and fill.
 - d. Design slopes within minimum and maximum tolerances to insure positive drainage, ease of maintenance, and prevention of erosion.
 - e. Grading Around Trees to be Preserved
 - The maximum fill allowed within the drip line of any tree (the area encompassed by the tree's longest branches) shall be 6". No cut shall be permitted within the drip line area.
 - When more than 6" of fill is required, the tree should be removed. In the case of significant specimens, protect with a terrace or drywell.
 - Provide positive drainage away from the base of all trees.

4. Drainage of Paved Areas

- a. In general, all new or rehabilitated parking lots at commuter rail stations should have a storm drainage system connecting with an existing municipal system.
- b. Minimum and maximum slopes in paved areas will vary with the material and location, but should be as prescribed in the Circulation and Parking sections of this manual.

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- c. Design flows for the system should be determined by using the Rational Method (or an accepted alternative) and as detailed in Manual No. 37, <u>Design and Construction of Sanitary and Storm Sewers</u>, American Society of Civil Engineers.
- d. The selection of a particular storm frequency and discharge capacity should be based upon the need for maximum reliability of operation, consistent with economy and local experience. The following chart can be used as a guide in determining the storm frequency.

Storm Frequency in Years	Drainage System Element
5 10	Secondary ditches Median ditches, gutters, ditch inlets, curb and paved area inlets, and inlet ponding
25	All pipes and culverts except under major roads and culvert outlets
50	Relocated stream channels, major stream structures, transverse pipes, culverts, etc. under major roads
100	Use only when required by the local agency

- e. Hydraulics: in the design of a storm drain system, the following factors should be considered:
 - Topography: avoid designs that require pumping
 - Economy of construction: avoid excessively deep cuts
 - Peak flows
 - Slopes: determine slopes required for proper self-cleaning at minimum flows
 - Minimum pipe size: 12 inches
 - Maximum velocity: up to 10 feet per second
 - Hydraulic design should be in accordance with manual No. 37, <u>Design and Construction of Sanitary and Storm Sewers</u>, American society of Civil Engineers. Coefficients of roughness should be as recommended in that manual.
- f. Gravity Flow: provide a self-cleaning velocity of 2 feet per second. Where this minimum is impractical to obtain, the design should consider the effects of sedimentation, odors, and operational difficulties at lower velocities.
- g. Water Collection
 - As illustrated in the diagram, continuous sheet flow of water into a swale located along an edge of flat areas,

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followed by the collection of this water in several area drains, is desirable. Area drains connected by ridges and valleys break up the continuity of paved surfaces and should be avoided.

- If area drains must be used, avoid strong linear paving patterns and reduce the pitch of the paving to the minimum.
- Trench drains are very expensive and should only be used where the collection of water in a small number of area drams is not practical, such as at the foot of some stairs and ramps.
- Coordinate the site drainage pattern with the design of barriers and curbs. For example, at some locations water from paved areas may flow to adjacent unpaved areas and be absorbed by the soil. In this situation, guard rail or bollards should be used instead of curbing as a barrier system at the edge of paved areas to prevent vehicles from destroying vegetation in the unpaved area.
- Coordinate drainage of the site with drainage of the track and roadbed to insure that water from one does not cause problems with the other.
- Where the presence of salt is likely, do not pitch the pavement to flush or recess planting areas.
- Avoid sheet flow across walks, ramps, and stairs.

5. Drainage of Unpaved Areas

- a. Unpaved or planted areas should be designed to absorb normal rainfall without draining onto paved areas. In areas with steep, planted slopes, horizontal run outs should be incorporated into the design to absorb the water run-off before it reaches a paved area.
- b. The range of acceptable natural slopes in unpaved areas is presented in the following chart.

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Landscaping

Type of Ground Cover	Maximum Slope	Desirable Maximum Slope	Minimum Slope	Desirable Slope
Mowed Lawn	3:1	4:1	1%	2%
Unmowed Lawn and Ground Cover Areas	3:1 (if jute mat used)	3:1 (Fill slope) 2:1 (cut slope)	2%	3%

D. PLANTING

- 1. The use of plant materials at commuter rail stations is one of the most effective means of enhancing the visual quality of a station, while at the same time performing an essential soil conservation function.
- 2. An important consideration in a station improvement program is the preservation of significant existing natural features— trees, shrubs, etc. By capitalizing on these features, new planting costs can often be kept to a minimum and concerned abutters may be reassured that the physical character of the site will not change dramatically. Among the actions that should be taken to preserve existing natural features are:
 - a. Wherever grading requires a cut of more than 6" or a fill of more than 4" at sites with good topsoil, the topsoil should be stripped and stored for later use.
 - b. Care should be taken in the scheduling and techniques of earth moving operations to insure that erosion of soil does not take place. Slopes that must remain unplanted or unfinished for substantial periods should have their soils stabilized with mulches, fast-growing temporary ground covers (rye, grass, or buckwheat) or man-made soil stabilizers (such as jute mats).
 - c. In areas that are to be cleared and grubbed, an analysis of all trees 2" and larger in diameter should be performed. Where possible, sound specimens of either soft or hardwood trees should be identified. They should be thinned to a minimum of 10'-0" on center and tagged for preservation. Exceptions to the thinning may be natural clumps of trees such as birches.

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3. Types of Planting

- a. Public areas in general and transit stations in particular can be difficult environments for the growth of plant material. Abuse by vandals, intense exposure to both vehicular and pedestrian traffic, and minimal maintenance all contribute to the condition.
- b. The list of recommended plant materials (on the following page), developed by the American Horticultural Society in the report Transit Planting: A Manual, accounts for these problems. The report's criteria for selection are:
 - Climatic zone suitability
 - Durability (including pollution resistance)
 - All year performance
 - Long life span
 - Low-cost maintenance
 - Artistic utilization and availability
- c. This list is not necessarily a definitive list for all planting that may be used at stations. Most of the materials were chosen for durability in urban locations or proximity to parking or roads. Many of the Authority's commuter rail stations are in suburban or rural areas without the major impact of vehicular and city pollution. Many of these stations have fine specimens of indigenous plant material. Consequently, the designer should also consider plantings that have already proven their suitability for a particular site.
- d. Plant materials should require little care other than initial planting and cultivation. Grass should not be used except in those cases where the Authority enters into agreements with municipal or commercial establishments to provide maintenance, or where the appearance of uncut grass is not objectionable. Bushes and shrubs should not require trimming or pruning. Fruit bearing trees should also be avoided.

4. Location of Planting

a. Planting materials can reinforce the pedestrian circulation, but for the most part, cannot control it. Careful planning of access points to the site and platform area will help insure that planting areas do not become "short cut" paths.

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Recommended Plant Materials

TREES

Acer platanoides
Acer rubrum
Amelanchier candensis
Carpinus betulus
Cornus mas
Fraxinus pennsylvanica
Ginko biloba
(Norway Maple)
(Red Maple
(Red Maple
(Serviceberry)
(European Hornbean)
(Cornelian Cherry)
(Green Ash)
(Ginkgo)

Halesia carolina (Carolina Silverbell Ilex opaca (American Holly)

Koelreuteria paniculata (Goldenrain-tree)
Liquidambar styraciflua (Sweet-Gum)

Phellodendron amurense (Amur Cork-tree)

Pyrus calleryana 'Bradford' (Bradford Pear)

Quercus phellos (Willow Oak)

Sophora iaponica (Japanese Panoda-tree)

Sophora japonica (Japanese Pagoda-tree)
Tilia cordata (Littleleaf-Linden)

SHRUBS

Abelia grandiflora (Glossy Abelia)
Acanthopanax sieboldianus (Aralia)

Berberis thunbergil (Japanese Barberry)

Buxus microphylla var. japonica (Japanese Boxwood)

Chioanthus virginicus (Fringe-tree)

 Deutzia gracilis
 (Slender Deutzia)

 Elaeagnus angustifolia
 (Russian Olive)

 Forsythia x intermedia
 (Forsythia)

 Ilex crenata
 (Japanese Holly)

 Juniperus chinensis "Pfitzerianas"
 (Pfitzer Juniper)

Kolkwitzia amabilis
Rhus copallina
Spiraea x vanhouttei
Taxus cuspidata
Xanthorhiza simplicissima
(Beautybush)
(Shining Sumac)
(Vanhouette Spirea)
(Japanese Yew)
(Yellowroot)

GROUND COVERS

Ajuga reptans (Bugleweed)
Arctostaphylas uva-ursi (Bearberry)

<u>Cotoneaster horizontalis</u> (Rockspray Cotoneaster)

Epimedium sp. (Forsythia)

Hedera helix (English Ivy)

Hemerocallis sp. (Daylily)

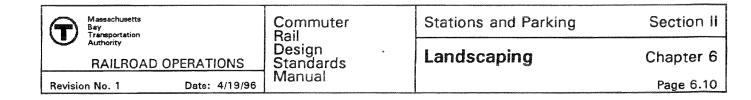
Ilex crenata (Japanese Holly)

Juniper chinensis 'Pfitzerianas' (Pfitzer Juniper)

Lonicera japonica (Japanese Honeysuckle)

Rosa wichuraiana (Memorial Rose)
Sedum acre (Goldmoss Stonecrop)

<u>Vinca minor</u> (Periwinkle)



- b. Shrubs should be planted so that when mature, they will not overhang walkways or platform areas.
- c. Trees that overhang walkways and waiting areas should be of a species whose lower limbs are of sufficient height to allow comfortable pedestrian circulation.
- d. In general, trees should be clustered in designated areas of a parking lot rather than scattered throughout the lot. In all cases, trees planted adjacent to parking areas should be carefully protected with bollards or curbs.
- e. Where traffic islands or planted strips are located within parking areas, plant materials should be selected with snow removal in mind. Plants should also not grow high enough to obstruct motorist's view. The planting must be able to bear the weight of accumulated snow, and trees should be planted a minimum of 8'-0" from the curb edge where snow would be deposited by plows, and small bushes should be avoided. In general, only low, hardy ground covers, grass, or non-plant ground covers should be used. Do not locate trees or other plant materials at random throughout a parking area because of these snow problems and the loss of space that can be used for parking. Concentrate planting in a few areas with a high visual impact.

f. Non-Plant Ground Covers

- Fabric weed barriers: Used before ground covers are applied. It is also used to keep mulch on sloped areas from sliding down.
- Small stones or gravel: Also used as a ground cover.
- Mulch: There are two general categories of mulch. Grass mulch consists of salt marsh hay or straw and is applied using an asphaltic binder, which holds the soil together until the seed is established. This mulch may also be used as a temporary soil erosion measure during construction. Bedding mulch is used to keep down weeds and to retain surface moisture around trees and shrubs. It also provides an attractive uniform ground plane surface. Three types of bedding mulch may be used:
- Wood chips from local sources are usually the cheapest form of mulch and provide a coarse, light-gray appearance. Wood chips vary greatly in quality.
- Pine bark mulch provides a darker, more uniform color and has a fine texture. It tends not to stay in place on sloping surfaces.
- Fir chunk bark mulch is the most expensive mulch, but it provides excellent uniform color and texture. Larger dimension and weight gives it a longer life span than the other mulches.

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IV. DESIGN CRITERIA AND DETAILS

A. GENERAL

Design criteria are described in this section for site drainage and planting. Since the design of these items tends to be site specific, only general criteria are presented below.

B. SITE DRAINAGE

1. Materials

- a. General Guidelines: the selection of the type of pipe to be utilized should be governed by the following factors:
 - Permanency of the facility
 - Static and impact loads which the pipe must sustain
 - Physical and chemical characteristics of soil
 - Physical and chemical characteristics of fluids
 - Availability of materials and the relative economics of construction of the installation
 - Initial cost versus maintenance cost of the system
- b. All materials and installation methods shall conform with the Commonwealth of Massachusetts Department of Public Works <u>Standard Specifications for Highways and Bridges</u>.

2. Storm Drainage Pipe

- a. Materials and structural requirements shall be detailed in Manual No. 37, <u>Design and Construction of Sanitary and Storm Sewers</u>. American Society of Civil Engineers.
- b. Class shall be as required for strength.
- c. Acceptable types of pipe are cast iron, reinforced concrete (both circular and elliptical), asbestos-coated corrugated metal. Where the base metal of the corrugated pipe is steel, it shall be galvanized.
- 3. Manholes, Basins, and Inlets
 - a. Provide manholes at maximum intervals of 300'-0" for drains 48" or smaller, and 600'-0" for drains 54" and larger. Minimum inside diameter shall be 4'-0". Minimum wall thickness shall be as required for depth of structure, but in no case less than 5".
 - b. Provide manholes at every junction, change in alignment, or change in grade of all drains.
 - c. All collection structures shall be self-cleaning and draining. Do not use cushions because of insect and odor problems.

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- d. Each culvert or drain 15" or more in diameter shall be provided with a secured, but removable bar screen at the inlet and outlet structure to prevent children from crawling into the pipe. To reduce clogging of the inlet screen, use sloped vertical bars so that debris will ride up the bars during flow.
- e. All structures other than inlets shall be provided with steps meeting OSHA requirements. Minimum access opening shall be 22".
- f. Drainage inlets in curbed roadways shall be curb type inlets.
- g. Provide wing walls at inlets and outlets to improve flow. Energy dissipaters, flared ends, and erosion protection such as rip rap, gabion walls, or paved aprons should be utilized where flows can be expected to scour down-stream channels.
- h. All grates, covers, and lids shall be cast iron with no primer or coatings. All inlet grates located in roadways and walkways should be designed to avoid trapping bicycles.

C. PLANTING

- 1. The American Horticultural Society, in the report referenced earlier in this subsection, identifies five types of plant material and three areas of a station in which plantings might be used.
- 2. Plant Types
 - a. Large trees: deciduous trees which reach the most monumental proportions, are long lived, and are suitable for planting as space definers and shade producers.
 - b. Small trees: deciduous flowering trees which, at mature height and branching structure, are most likely to conflict with space required for pedestrians unless they are sited properly.
 - c. Evergreen trees: coniferous evergreen forest species with a large mature height.
 - d. Shrubs: deciduous or evergreen, broadleaf or coniferous, which are adaptable to local conditions and retain their form without pruning.
 - e. Ground cover: typical are the evergreen perennials with a dwarfed or prostrate condition and which are adaptable to local conditions.

Plant Material Usage

Description/Us	sage	Large Trees	Small Trees	Evergreen Trees	Shrubs	Ground Covers
Mature height ¹		75'- 0" or greater	25'- 35'	50'- 0"	20'- 0"2	24"
Mature spread ¹		50'- 0" or greater	20'- 35'	35'- 0"	15'- 0"	Up to 6'- 0"
Station Entry Zone	Minimum size at planting	4"- 5" caliper	3"- 3 1/12" caliper	NA	3'- 5' height 3'- 5' spread	2-year plants or 24" spread
	Minimum branch height	7'- 0"	4'- 6"	NA	NA	NA
General Circulation	Minimum size at planting	3"- 3 1/2" caliper	NA	NA	3'- 0" height 3'- 0" spread	2-year plants or 20" spread
	Minimum branch height	6 - 0"	NA	NA	NA	NA
Peripheral Areas	Minimum size at planting	3"- 3 1/2" caliper	2"- 2 1/2" caliper	3"- 3 1/2" caliper	3'- 0" height 3'- 0" spread	2-year plants or 20" spread
	Minimum branch height	5'- 0"	3'- 0"	NA	NA	NA
Minimum spac (massing and s		20'- 0" o.c. ³	10'- 0" o.c.	10'- 0" o.c.	2 1/2'- 3' o.c.	12" o.c. or 24" o.c.
Minimum spacing (in circulation spaces)		25'- 0" o.c.	NA	NA	2 1/2'- 3' o.c.	12" o.c.
Maximum spacing (in circulation spaces)		45'- 0" o.c.	NA	NA	5'- 0" o.c.	24" o.c.

Mature height and spread as listed in <u>Trees for American Gardens</u> and <u>Shrubs for American Gardens</u> by Donald Wyman. While it is understood that in urban conditions plants do not reach their normal mature heights and spread, the dimensions listed in this table shall be used in conjunction with the height and spread dimensions listed in Wyman's books for the purpose of specie selection.

- 2 5'- 0" in station entry zone.
- 3 On center.

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3. Station Areas for Planting

- a. Station entry zone: the area adjacent to primary access street, including the main vehicular and pedestrian access and drop-off area(s).
- b. General circulation: all secondary pedestrian access routes, including plantings within parking areas and adjacent to platforms.
- c. Peripheral Areas: areas not used by pedestrians or vehicles that either need general ground covers or that provide the opportunity to screen the station from the surrounding community.
- 4. The matrix on the preceding page identifies the preferred size and location of each type of planting in each station area.

5. Planting Requirements

- a. Existing topsoil at each location should be examined to determine suitability for use in planting areas. Acceptable topsoil is defined as a friable loam, neither heavy in clay nor light in sand, containing a minimum of 3% organic matter and having an acidity range of (pH) 5.5 to 7.5. If the soil is found unsuitable, it shall either be improved to an acceptable state or removed from the planting area and replaced with a new soil meeting these criteria.
- b. Soil of good fertility and friability shall be provided for the top 6" of lawn areas, the top 12" in shrub and perennial beds, and in a zone of 12" around the root balls of all trees, as illustrated on following pages.
- c. Planting should be designed to survive without any supplemental irrigation after the first year.
- d. Grasses may be either mowed or un-mowed. Mowed grasses used near circulation areas should be of a high quality perennial seed mix suitable to the locality and site conditions. Un-mowed grasses should be coarser grasses and may have non-grass flower species mixed in.
- e. Sod may be used to establish grass areas where economics dictate or when it is desirable to use seed mixes not available as sod. When sod is applied on slopes greater than 4:1, use jute matting. All seeded areas should be mulched.

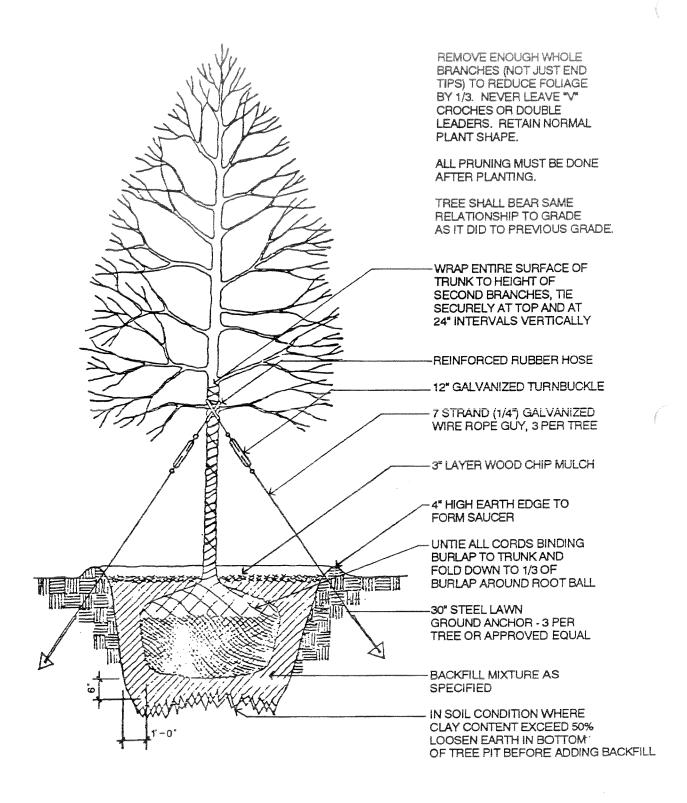
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- f. Broadleaf ground cover and bedding plants should be planted using 2" peat pots and spaced 12" to 18" apart in each direction. Coniferous ground covers should be containerized plants with a minimum of an 18" to 24" spread and planted between 2'-0" and 3'-0" apart. All beds for ground cover and bedding plants should be covered with 3" of bark mulch.
- g. Do not use plant material of a type, or in a location, where it will spread into the track area and foul the ballast and drainage. Chemicals that kill vegetation are often used along the track right-of-way to eliminate unwanted plant material.

6. Tree Grates

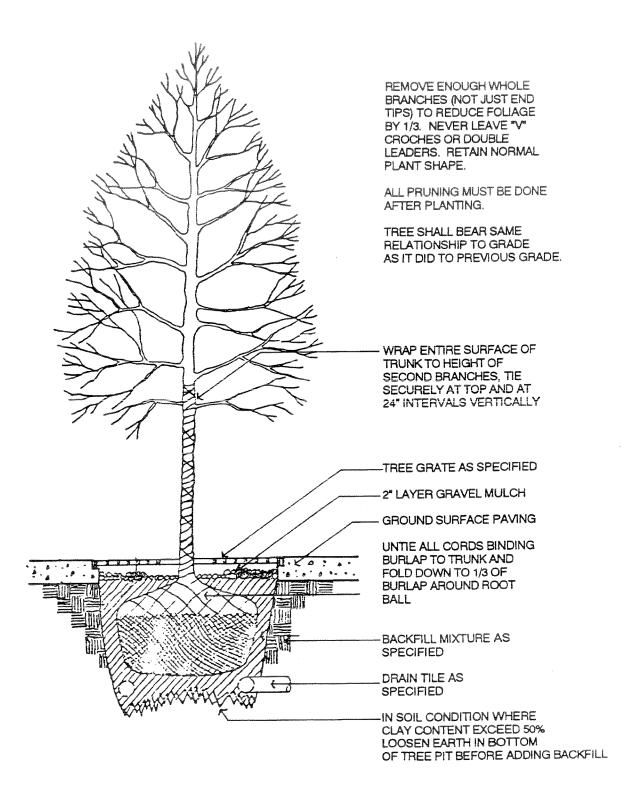
All tree grates shall be cast iron with no primers or coatings. They should be round or square, such as those illustrated on the following pages.

Typical Tree Planting Detail in Unpaved Area



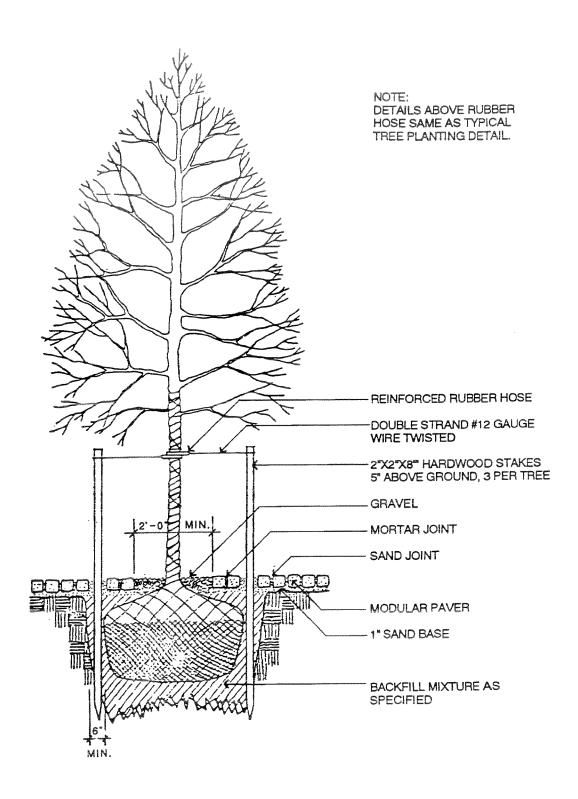
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Typical Planting Detail Using Tree Grate



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Typical Tree Planting Detail in Area of Modular Paving, Such as Granite Block

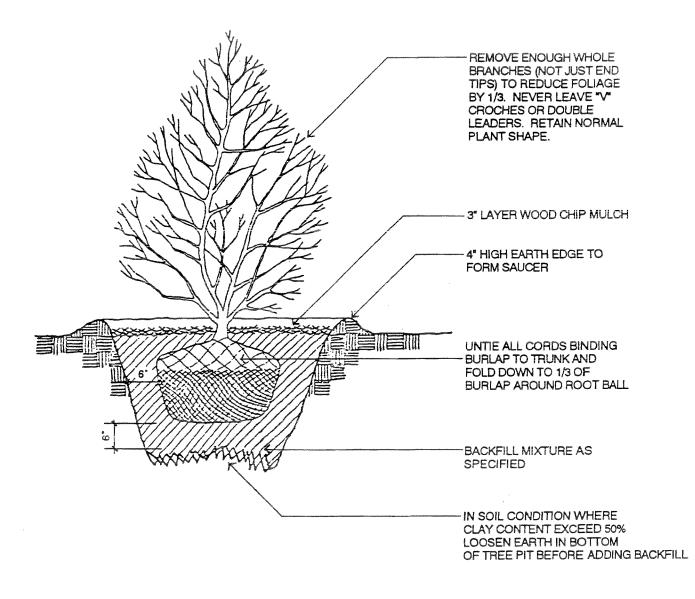


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Typical Shrub Planting Detail

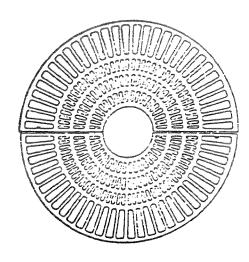
ALL PRUNING MUST BE DONE AFTER PLANTING

SHRUB SHALL BEAR SAME RELATIONSHIP TO GRADE AS IT DID TO PREVIOUS GRADE.

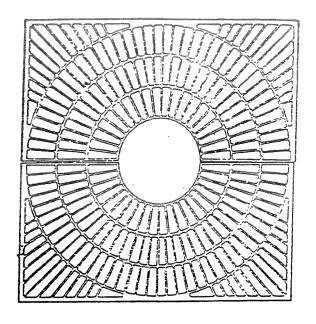


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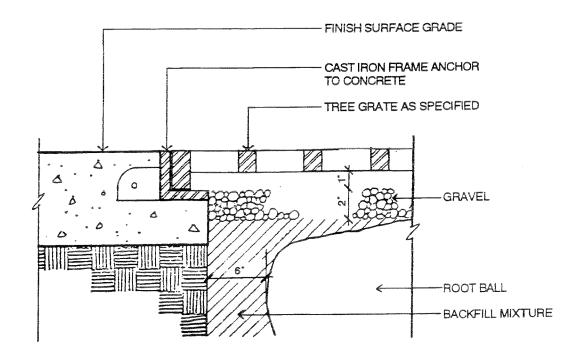
Typical Tree Grates and Installation Detail

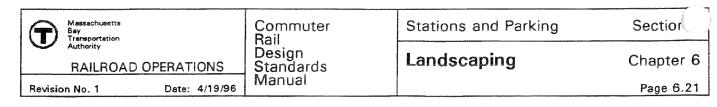


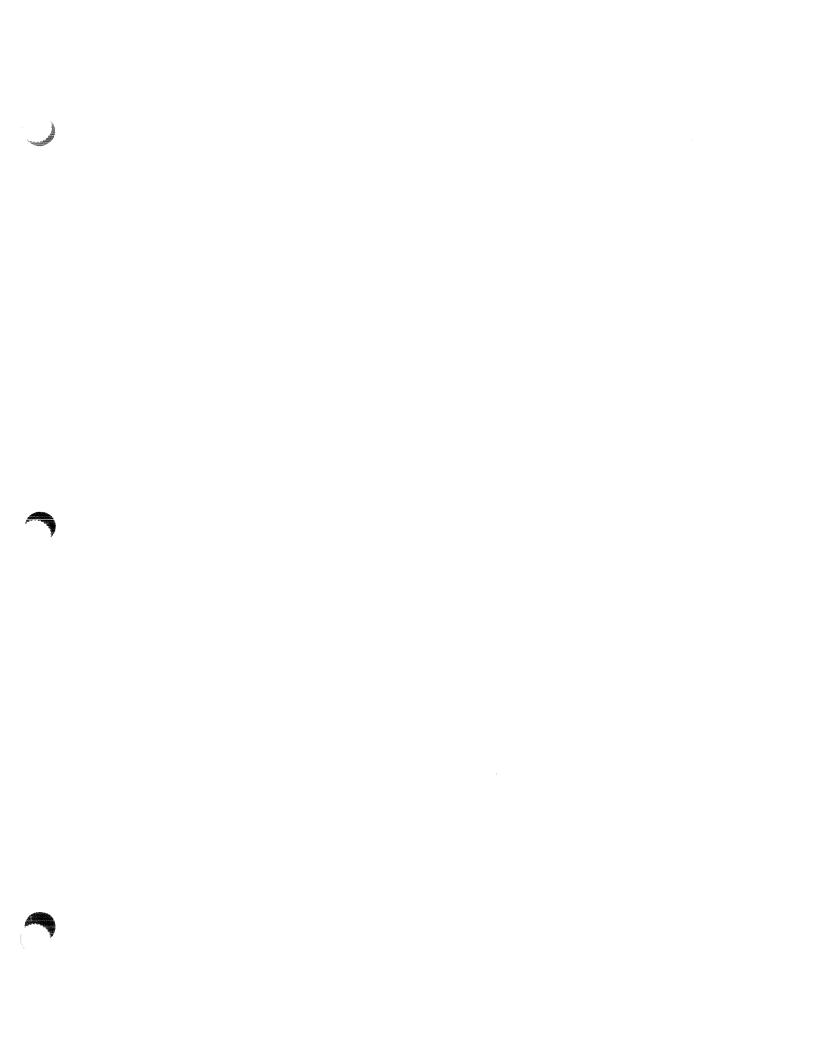
180° ROUND PREFERRED FOR CONCRETE, ASPHALT OR MODULAR PAVING WITHOUT A STRONG PATTERN



180° SQUARE
PREFERRED FOR MODULAR
PAVING WITH A STRONG
RECTILINEAR PATTERN







NOTES ON REVISION DATED 10-28-92

this revision of the Communer Rull Book of Standard Plans Track and Rondway, drued Outober 28, 1992, represents a complete replacement of the previous document dated November 17, 1986. Plan holdors are hereby directed to remove all material between the binders of their present books and replace with the enclosed package. Of the 86 plans in the previous bunk only 16 were not revised. Those 16 are included in this package to simplify updating the backs. A total of 55 new plans have been added

The new plans include:

Additional material on clearances

Side track installation

Hot mix asphalt underlayment at turnouts

Fransitions from track of varying track modulus

Frost bracing and blocking

Various spikes

Plates for use with screw spikes in turnouts

A different turnout design using floating heel blocks and longer switch rails.

Derails

Bumping posts

Grade crossing

Fences & gates

Additional signs

solid heel blocks is retained. Minor revisions have been made to that design including the turnouts. The new design features 60 foot undercut stock rails, longer switch rails, floating neel blocks, uniform risers and 19'-6" long bonded insulated joint plug rails. These turnouts There are currently two turnout designs in the standards. The original design which uses rail layout and insulated joint locations. There are new designs for the number 10,15 & 20 Unless otherwise specified, the new floating heel block turnouts shall be furnished with any new orders. The original design of 1986 will be used only for replacement of material or are identified as "Floating Heel Block" turnouts to distinguish them from the original design. certain specific applications when approved by the Chief Engineering Officer.

Many of the unnour datail plans such as vertical switch rods, switch places and the frogs are common to both turnout designs. The original plans for those elements have buen modified to allow their use with either design.

2150 and 2200 number series are for number 8, 10,15, & 20 numouts respectively. The new design, which is a revision to the original, adds one to the middle number so that 2110, 2160 As an aid to finding the various turnouts, an explanation of the plan manifering system may be helpful. Special trackwork and related material are numbered in the 2000 series. The two middle numbers denote the frog number of the original design turnout: that is, 2080, 2100, and 2210 number series indicates the new design for number 10,15 & 20 turnouts. As noted in the paragraph above, the plans of details such as switch plates and switch rods are common to both turnout designs. Another significant change is that all resilient fastener turnout plates have been changed to provide for lagging with screw spikes rather than lock spikes. Lock spikes will now be used only in conventional timber and ballasted track construction outside of special trackwork As information, the following plans from the 11-17-86 issue have been deleted and not replaced:

1010 - Minimum Clearances for Railroad Equipment

3102 - Typical Section - Chair Rail Crossing

3112 - Nelson-Chair Detail

In addition, the following plans have had the numbers modified;

3020-Has been renumbered to 3020-1 3021-Has been renumbered to 3020-2

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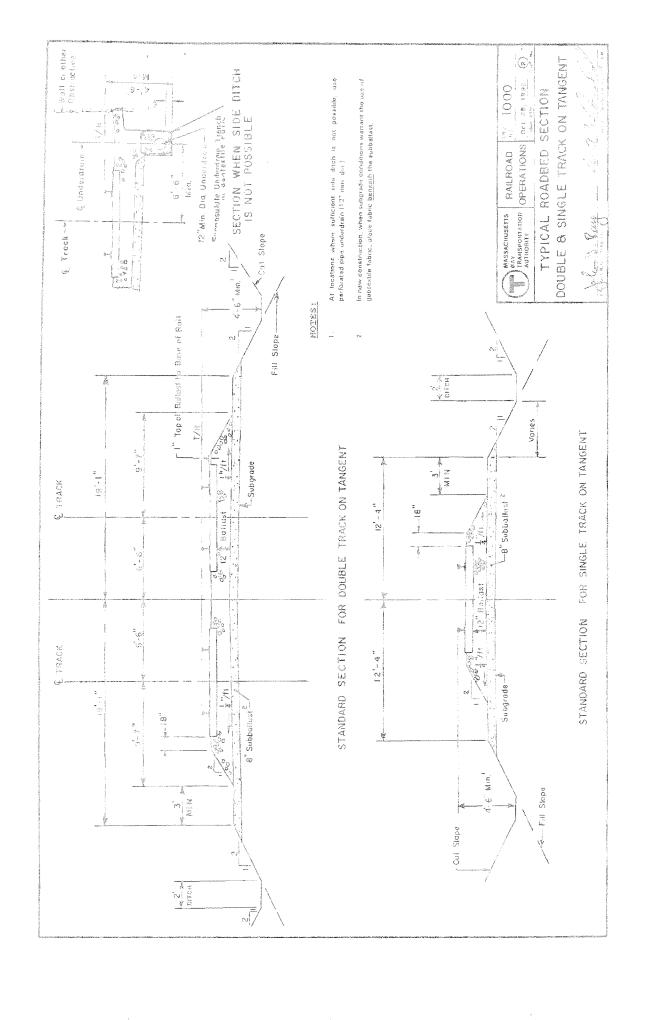
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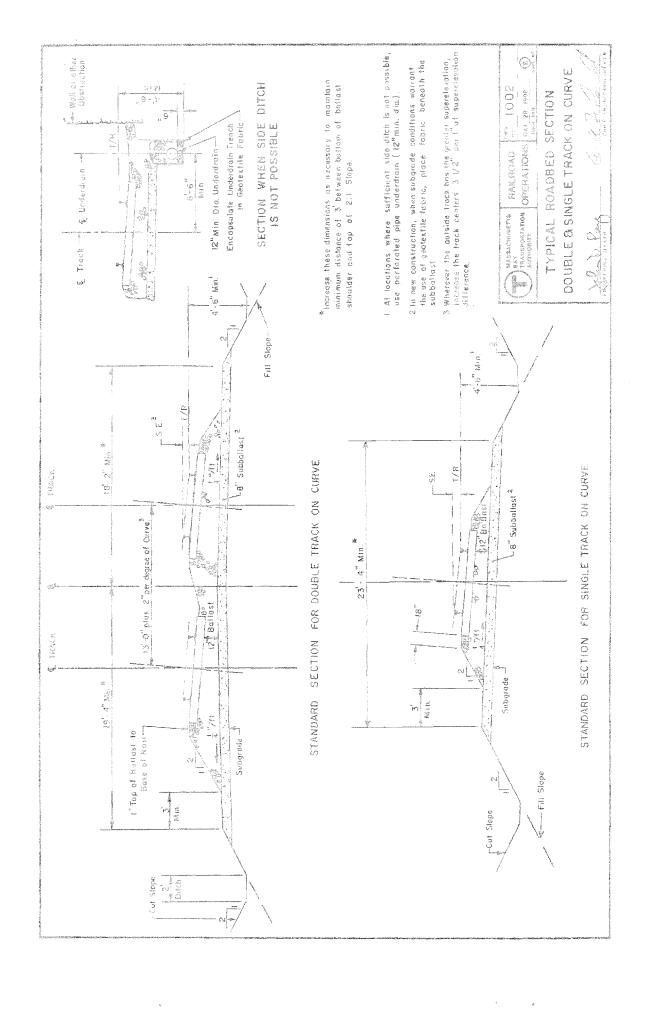
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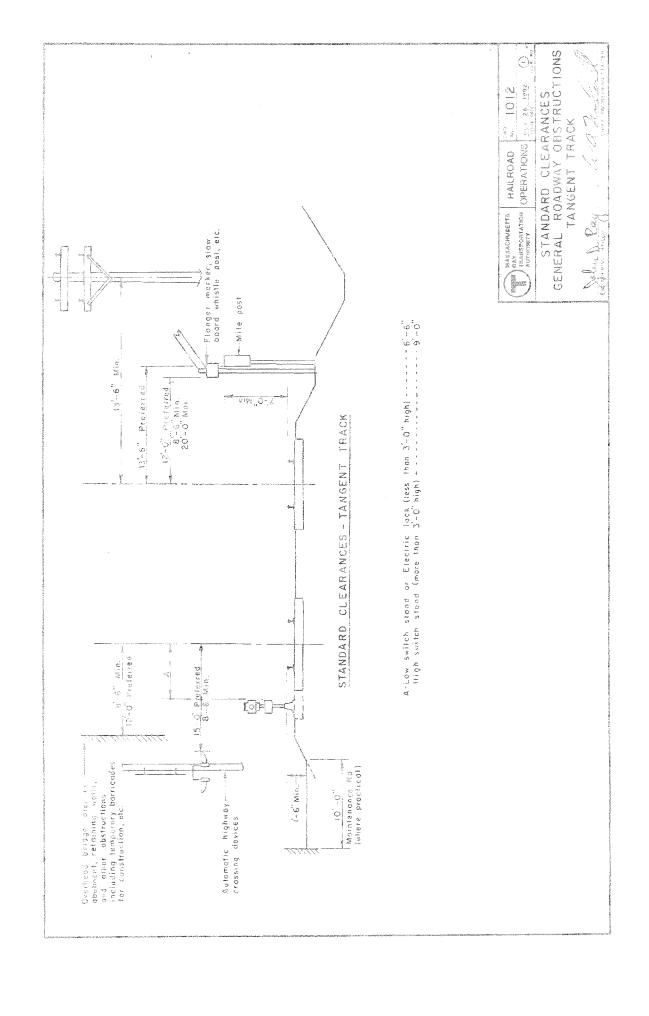
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	13'-3" Manganese Grad One Piana Guard Red	Guard Rail Isstellation and Mantananca	Frag Tie Mana. BaiBound Manganese Frag.	Saff Attended Shoulder Te Pates		Restlendly restained furbut Plates For Use Bothind Hopl of Switch With Gradusted Rivers	Table of Dimensions for Bosillendy Fastoned Tunner Plane with Conference Rivers	Crac Control of the C	Resiliantly Fastented Turhaut Flatas No. 8 & 10 Floating Heat Block Turnauts	Restliently Festerrad Turnout Plates No. 15 & 20 Floating Heal Block Turnouts	Heel Block and Switch Rail Stop - 13', 16'-6", 26' & 39' Switches	Resiliently Fastened Adjustable Rail Brace	Switch Point Guard	60 Ft. Undercut Stock Rail	No. 6 Solid Self-Guarded Manganase Steal Frog	No. 8 Solid Salt-Guarded Mangenose Steel Frog	No. 10 Solid Self-Guardad Mengenese Strok Freg	REPLACEMENT AND MAINTENANCE MATERIAL	Replacement Botts for Railbound Manganese	គឺរបស់ពួន 	Replacement Bolts for Self-Guarded Frogs	B&M No. 6 Railbound Manganese Steal Frag	B&M No. 8 Railbound Manganase Steel Frog	B&M No. 10 Ballsound Manganese Steel Frog	B&M No. 12 Reilbound Manganesa Steel Frog	B&M No. 15 Railbound Manganese Steel Frag	B&M No. 20 Railteannd Manganese Steel Frog
DRAWING	388	23.00	2326	23.28	:	9977	2341	**************************************	2342	2343	2350	2382	2356	2360	2370	2372	2,374	HEPLAC	2502		2504	2506	2508	2510	2512	2515	2520

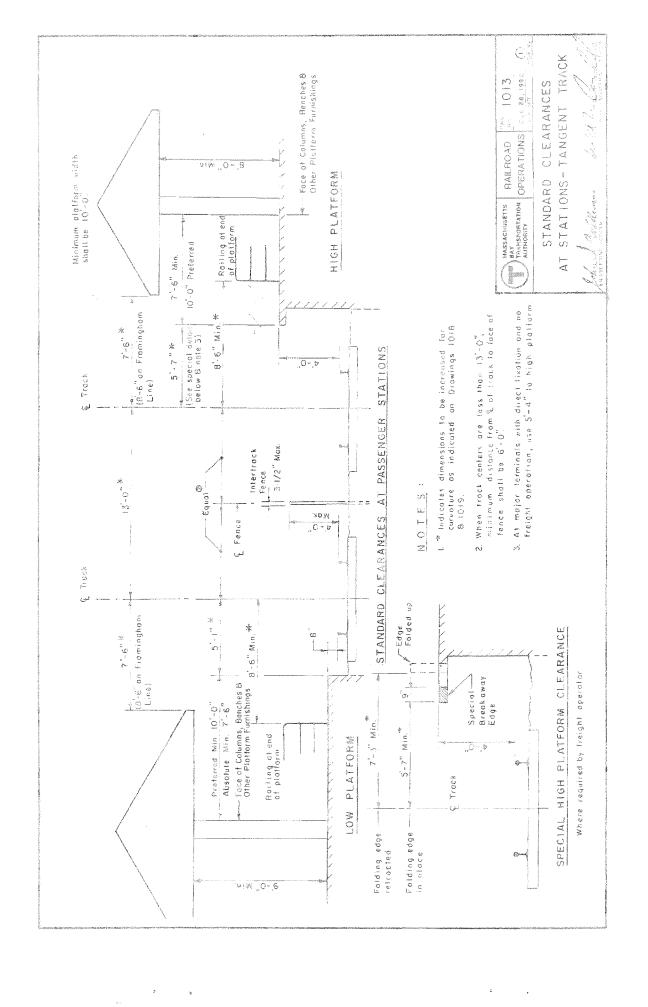
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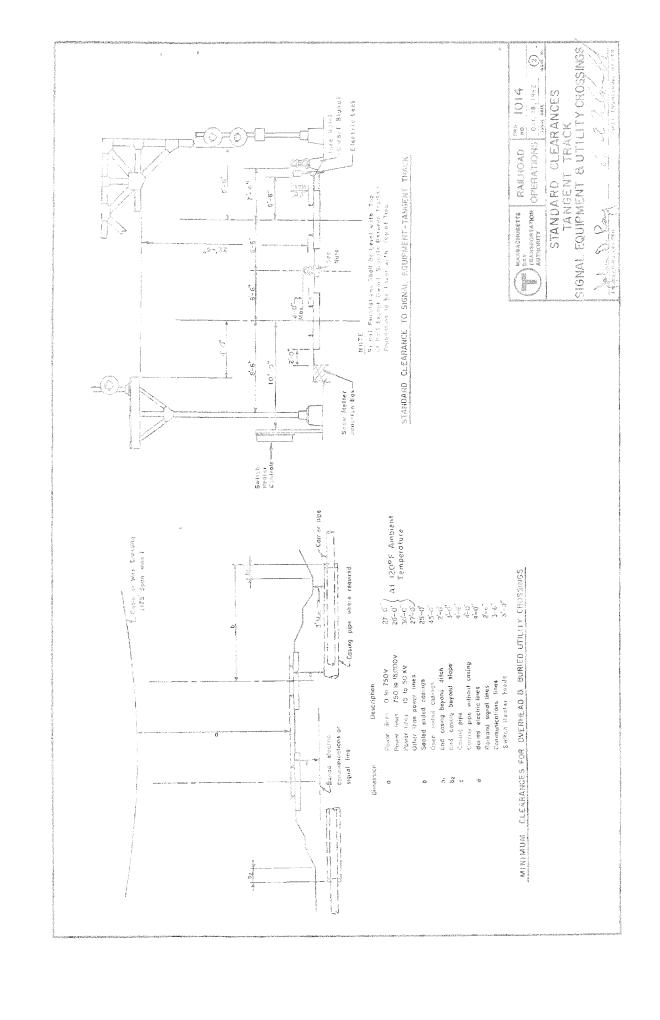
DA WING NO.		No.	
SK518			
2008	Note Process		10.28.92
23004	Speed Restrotions, Yard Linut & Flanger Signs	Herr	11-17-86
3300	Tempotery Slew Squids	2	10-28-82
2307	Table of Slow Board Placement Distances		10.28.92
3315	Close Clearance Signs	ç-m	11-17 86
3314	Otsaranca Warring Sign	,-	10.28.92
3344	Do Not the serviced Cabiles	p~	11-17-86
3352	No Trespassing Sign	2	10-28-92
3388	Public Crossing, No Warning Davices	ţ.eec	11-17-85
MISCELLANEOUS	AMEOUS		
4056	Steel Beam Guard Reil Detail		11.17.85

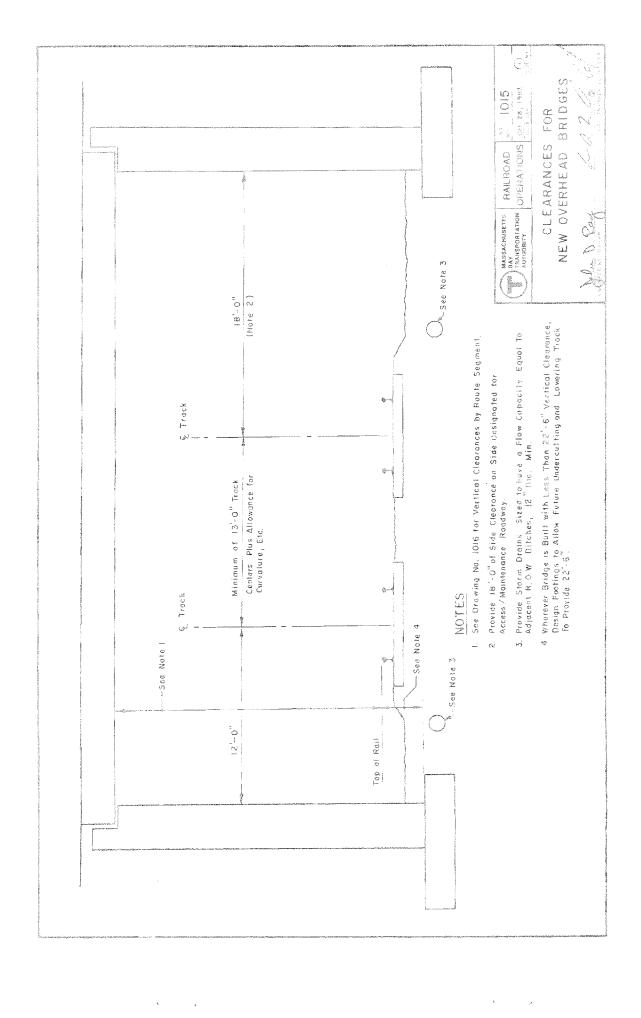












MINIMUM ACCEPTABLE VERTICAL CLEARANCES FOR MEW OVERHEAD STRUCTURES

Overhead Onstruction

017

10 - A

See Note I ---

PanathalD Inspent

po en enga abbangan independente en er folktoppalla (en de douberabath obsette en 1000 undependente papalador)	ingergene versiter etwelster etwens om om om en	STANDARY	Company of the properties of t	and and the state of the state	
		Min. C.			Č.
East Route Marr Live	Soson to Evereit Justinen	8	Francischen (66A) Mein Lese		.g - 23
Fast fewie Main Line	EVERGE LEASING IN MEWINEYDOR	5	Shore Line (N. E. Corrette)	Boston to Topolo Hand State Cree	10.0
Seugus Branch	Evenent Jurician to Lynn	9	Meschan Eranch	Forest Miles to Newton Upper Family	18,-0
Gloucester Branch	Bayary Junason to Producer	18 -0.	Oscham Secondary	Readville to Dedham	
Daners State	Salem to Durings	18:-0*	Stoughton Branch	Canton and to Whitemoon Joh	- Co
West Pour Main Line	Boston to Wilmington Junction	Š.	Milis Secondary	Needhem, Junction to Willis	180-
West Poste Warn Line	Withington Juneton to State Line	22' -6'	Frankin Brazon	Reachilla to Franklin	106.
Newburycon Braisch	Wakelield to Topsfuld	18,0	East Junction Secondary	Attisizaro to Sestionk	18'-0'
South Mickleton Branch	Wast Peatorty to South Middleton		Old Colony, Mann Line	Bosin to Brankins	18 -0-
Waleren	Liverence to State Line	18'-0"	Mittellaboro Secondary	Braintine to Middletoco	£ 20
New Hampshire Main Line	Bosson to Lowell (Blaachery)	20. 8,	Plymouth Secondary	Breintrue to Plymouth	1021
Now Hampahie Man Line	Lowell (Sleachery) to State Line	9-22	Graenbush Secondary	Braintree to Greenbuch	6-6
Wohum Branch	Winchester to Woburn	18'0"			
Stemeliam Branch	Monvale to Stonehem	.0 3:			
Wilcat	Withington to Withington Junction	30,-8			
Suffering Secondary	North Billerice to Bennett Hall	130.			
Frichburg Main Line	Boston to Willows (Ayer)	R			
FitchCurg Main Line	Willows (Ayer) to Fitchburg	22'-6"			
Central Mass, Branch	Clematis Brook to Berlin	5-3 <u>1</u>			
Marlboro Secondary	Husson to Marthono	\$ S			
GreenvilleBreigh	Ayer to N.H. State Line	18,0			

of Pail

906

Where there are vertical curves, coroulate and compensate for mid ordinate of an 85°-0" long cor.

 Suppressivated track is to have obserance measurements taken perpendicular to plane of the suppression as shown in destruct lines. SHOW

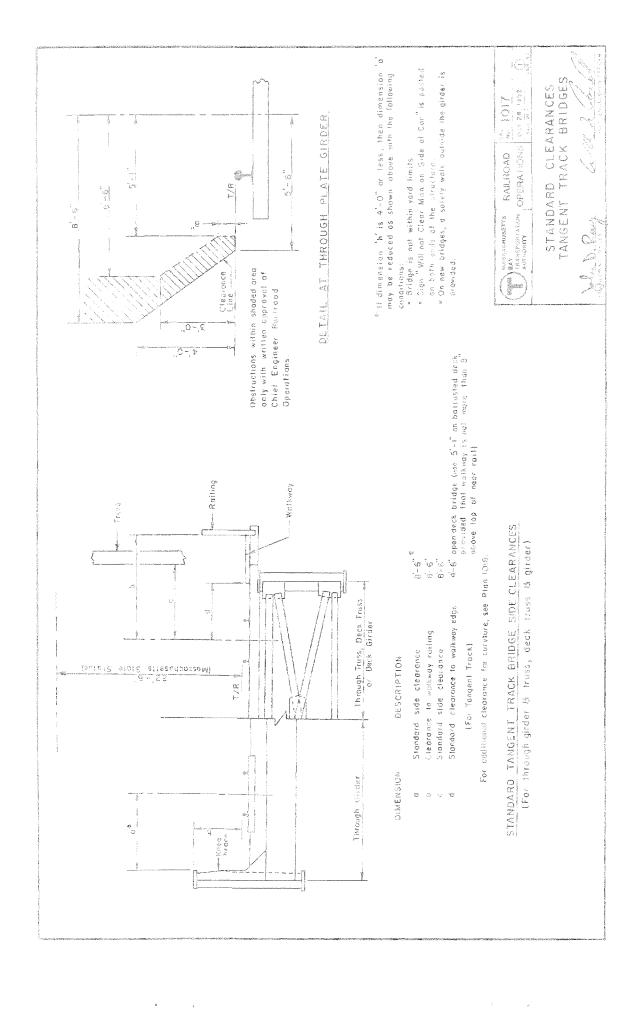
2. Vertical obserances shall be measured from the bewest projection (freet, bot), pipe, etc.) within 7ft, from centalities of track on each side, as shown.

3. Cleasement shown are maintain and require MBTA and Mess. DPU approvals under 22"-6".

MASSACHUZETTS RAILFROAD PRO 1016
AVERPRETATIONS CEL EST, 1972
AVERPRETATIONS CEL EST, 1972

MINIMUM VERTICAL CLEARANCES
BY ROUTE SEGMENT

88 Z

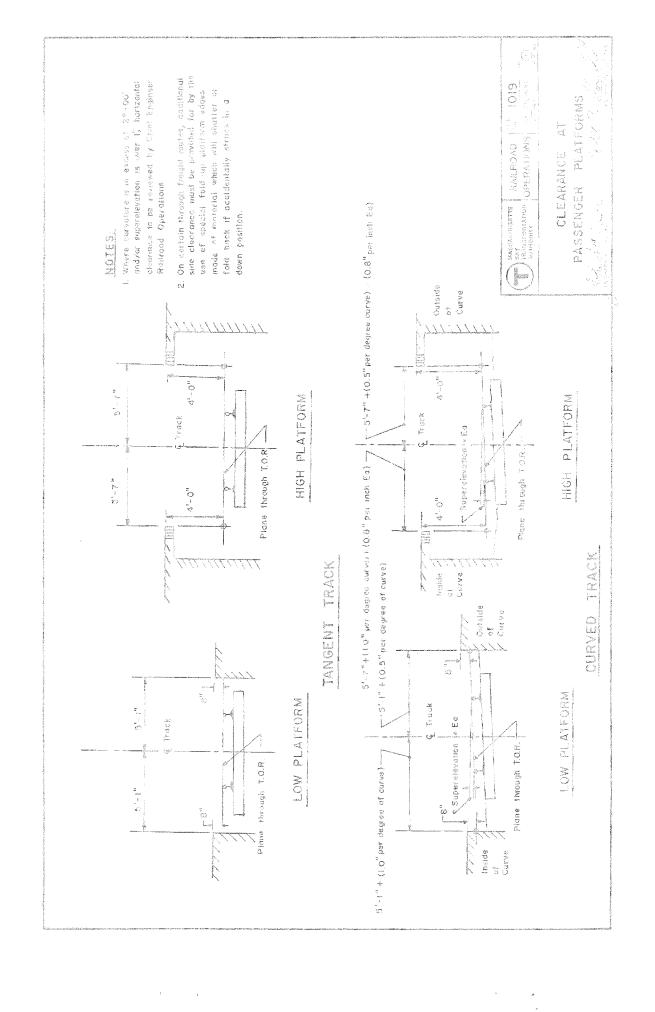


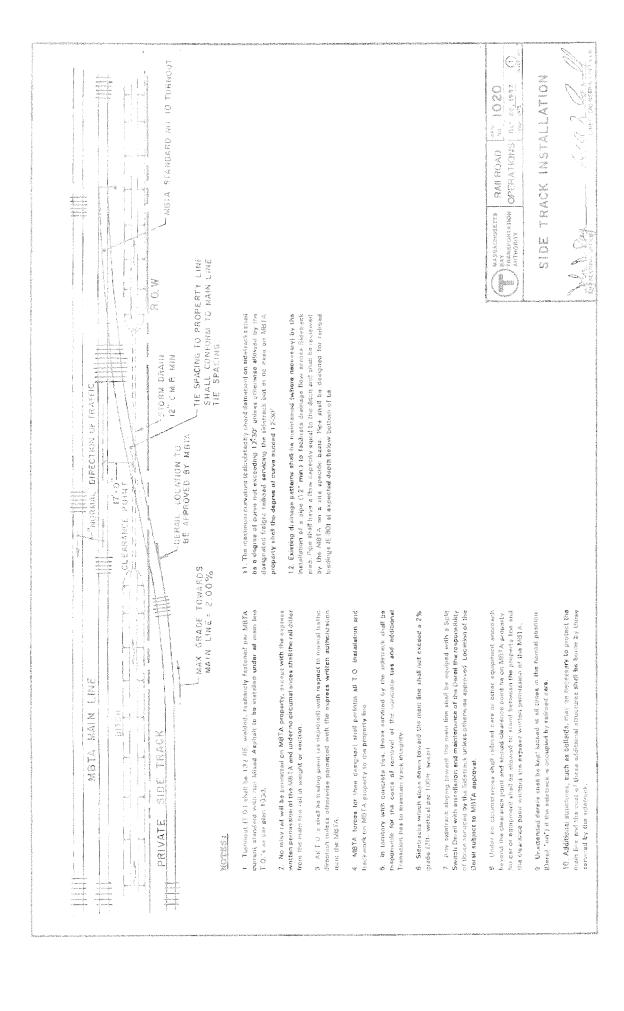
- 1" par 10 # 35 × 6/4 -* S-8---Phaneline Tracks or Yard Tracks -- '**_0" Maintine or Passing Track and Laddar Track--- 17***0" --2" Mario * For Clearance Adjustments of Passenger Platforms, see Dwg. No. 1019. Marshine Tracks or Yard Tracks --Ingreased side clearance for superelevation ~ ~ Where SE is Superelevation in Inches it is Height to Obstruction in Feet Standard side Charanace Tangent Track - - - - - Track paniers between . Increased side clearance for curyature --increased track centers for curvature --Chesisson 3007 61.64 "1+" 3-" 8 (3, 0"+2"ger !" m m +01 180 14 3.8 14/5 x 3E (%)4 Crimpal Classance Cleardaca Point 100

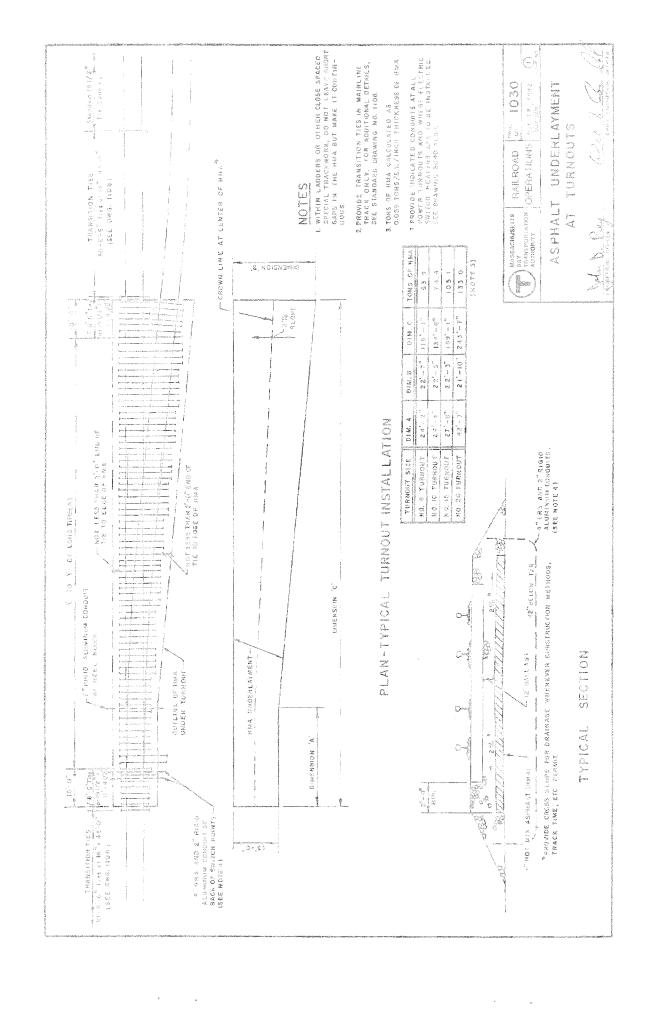
NOTE: Where possible, on IS-O' side clearance will be provided from the center line of one frack for a maintenance roadway.

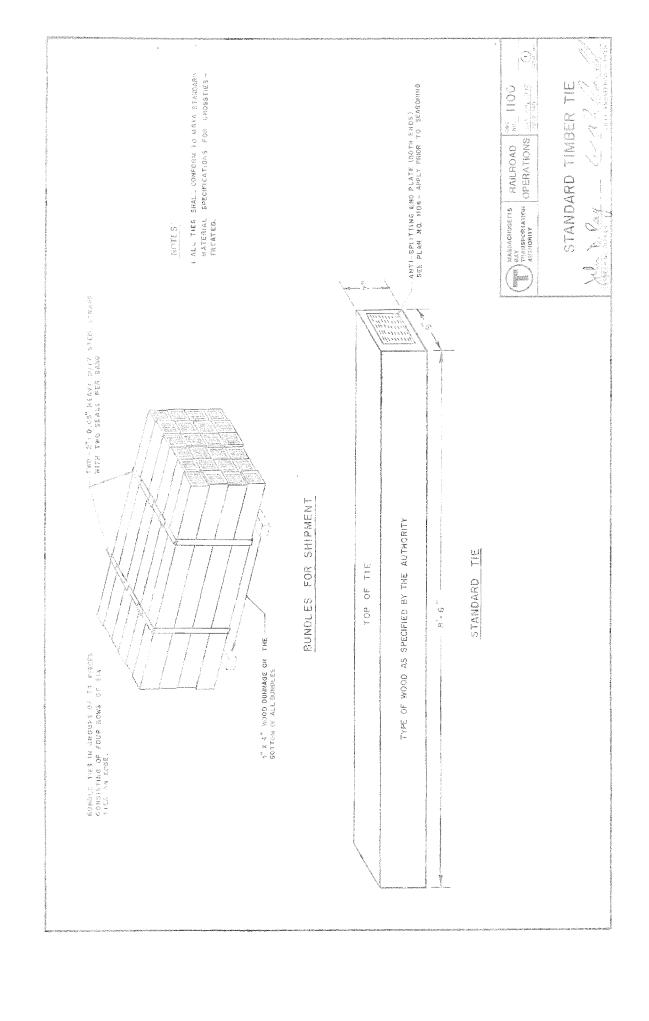
STANDARD TRACK CENTERS & SIDE CLEARANCE - CURVED TRACK

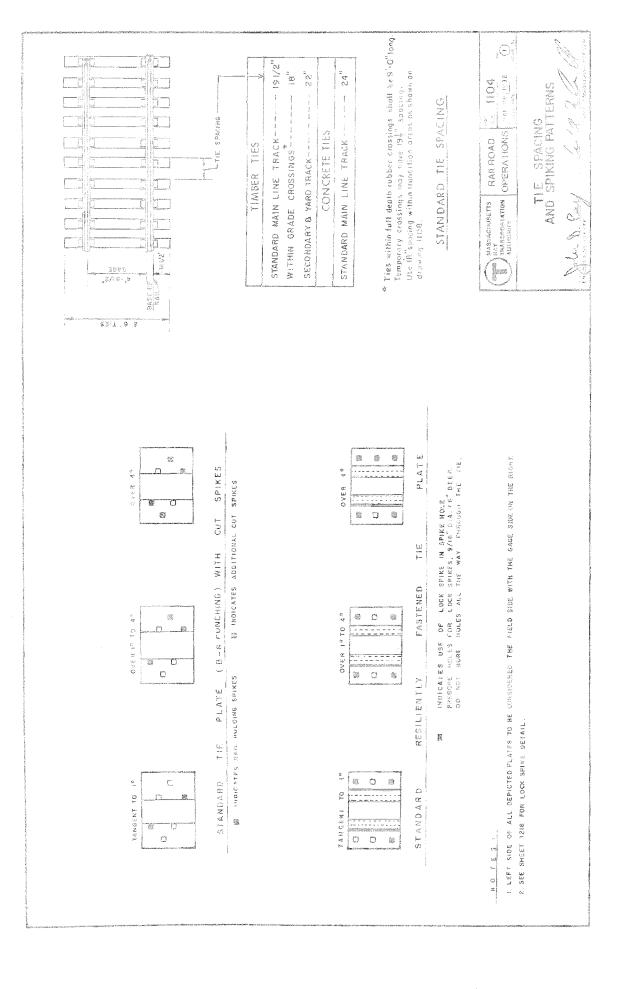
STANDARD TRACK CENTERS & SIDE CLEARANCE INCREASES FOR CURVED TRACK

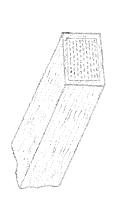




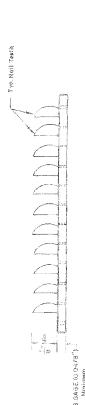


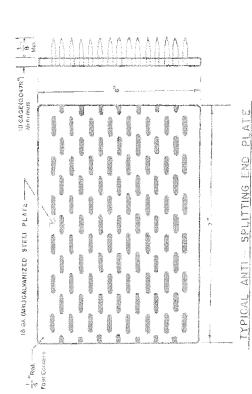






TYPICAL TIE END VIEW





- She Anti-Shitting Brig Photo philift challes incorrectly.
 On Philift W. J. policy levels along philips. But Support
- I The ASEP shad have earlies than the same and in a progressing of audicing shappeas to toly panetres hardwent tenhare used for core fies
- 3. This ASET that to exaction applied to the costs of a ter with a extent prostore and minimum touth kending and while be applied to that the roat reput. and on the place is deale with any neckens of the to-
- The ASS P is to be applied to naw ten pane to senso any
- 5. The assess of the ASEF is to be applied our more man Self off the

6. The ASEP shall be fabricated in such a way that the fasth twist vartically

in allow a bottler grip in the tie.

7. Mark and leated plates to indicate location of them

MAGAGANGERE RALFROAD W. 106

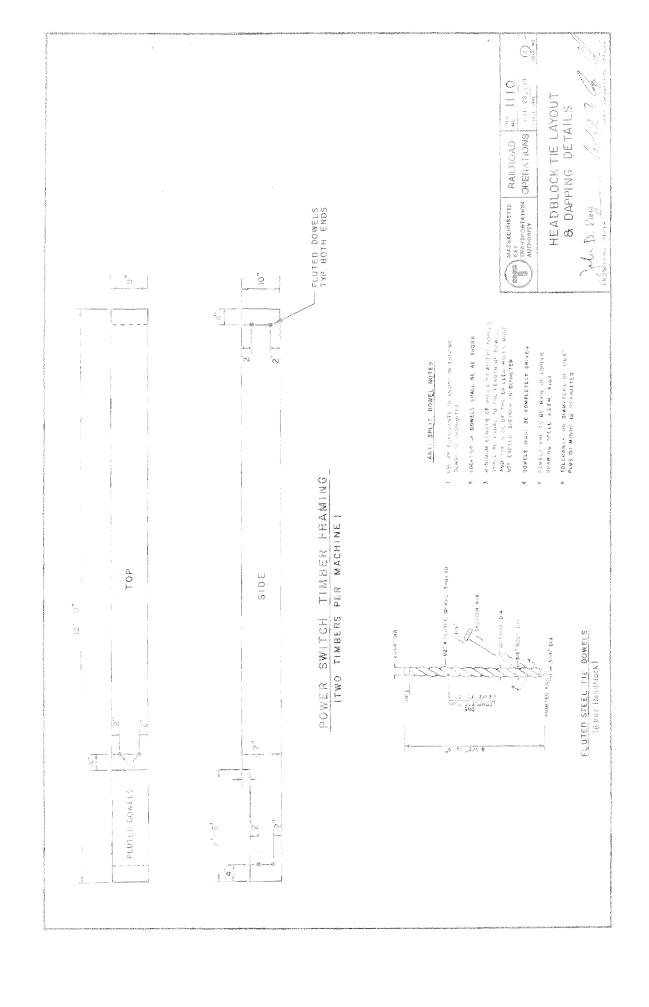
TRANSPORTATION OPERATIONS OG 26, 1992 (C)

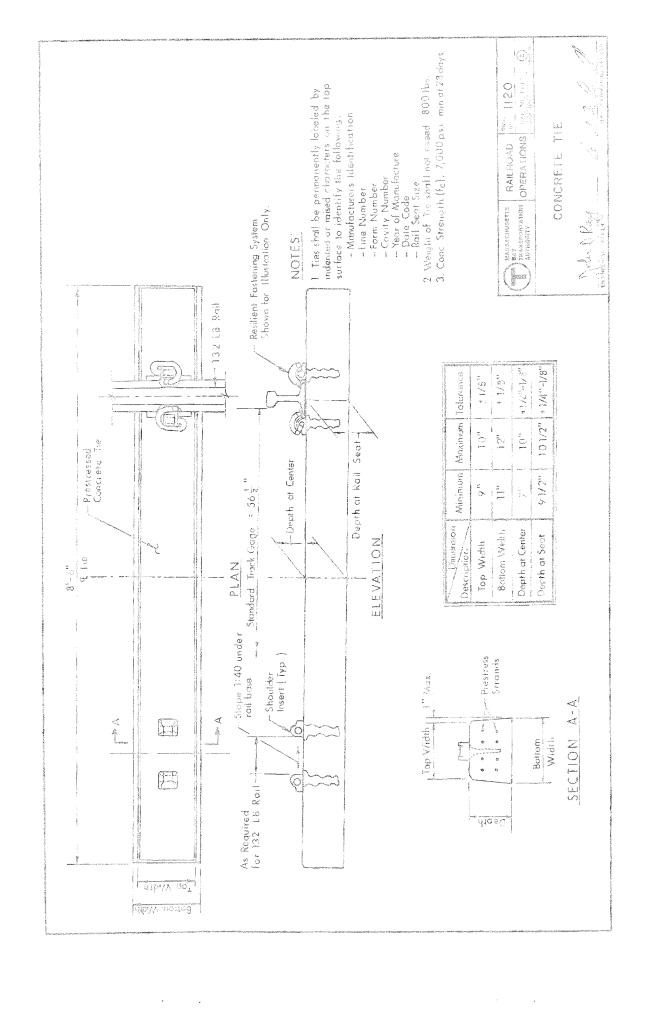
MITHORITY

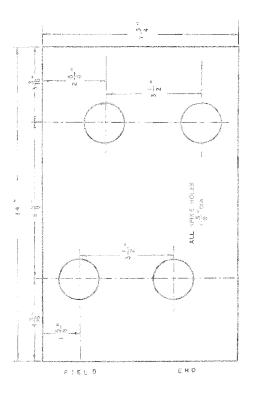
ANT-SPLETRO ENO PLATE DO CROSSTIES & SWITCH TIMBER

The Control of the Co

in track MASSAGHUSETTS TRANSPORTATION Undergrant TAR	Je in frock NASSACHUSETTS TRANSPORTATION AUTHORITY THE AUTHORITY AUTHORITY THE AUTHORITY AUTHORITY AUTHORITY THE AUTHORITY THE AUTHORITY AUTHOR	Tacter Track Support			TRANSITION TIES
Spacing: 45-0 Spacing: 45-0 Spacing: 45-0 In the space of the space	N O T West State of S	The manufacture of the second			RASSAGHUSETTS RAMSSYONTATION AUTHORITY THANSTON
	N O T West State of S	30, 8-6" Tass of 18" (new 2). Specing 1 45-0"		rer laste is a significant chonge in track own for speeds up to 60 mph. mph, lacressy as follows:	8" = 52"-6" 8" = 60".0" asists of any of the following: stab anxivation





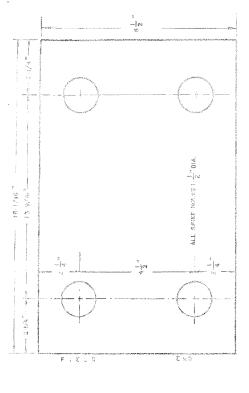


WOOD WHEN TO THE PLATES

As Shown Dimensions Will Fit Either (321b or 115 to Piote (6-8 Panching Only)

MOTES:

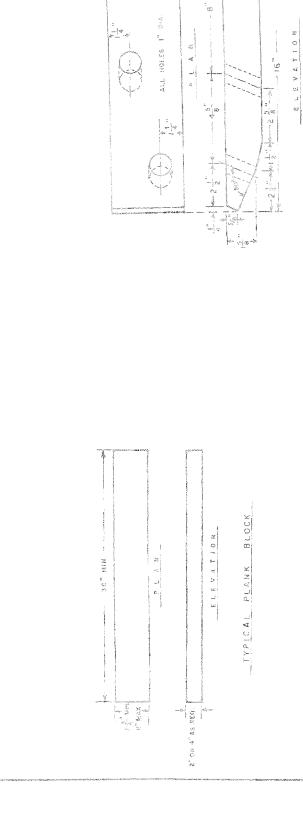
- 1. Shima shall be made of saved, seemd hardwood or manne plywood , probored as shown.
- 2. A venation of 1/8" more or 1/18" leas is offereable in langth or width with langth width width & dapti unitarn ino wedge shape allowed in any duscland.
- 3. Trackness of whites shad by in 1,4" increments from 1,2" to 1 3447.
- 4. Wend spikes not percenting I" in thickinse may be secured using a standard A" out spike hos shaming exceeding I" must be eccuted using special B" it and spikes
- For admittent that on use and interflature, use drawing 120% and NW-1Manual, SECTIONS, 213.126 and 213.134.



WOOD SHIM FOR RESILENTLY FASTERED THE PLATE

As Shown Cananalons Will Fit Either 1321b or 1531b Plote





HOTES:

- I Plank blocks are to contour to the dissostancest specifications for wood stime (deswitz) 1200f. Confidence in these anticles plans every. Het plans blocks are to be made liven hed wood with obligance pinte hedeling optionish to be borded in the feati.
- Frank trincing and supplied dispartly on top of the to-deniests the rest the fits to picta and supplied to the tie with spires or required to prover set the tie with spires or required to prover set the tie will spire to prove the tie tie. SCHOOL & HIGHER
- Where a rail is chimined 2" or more, a combination of stons and 2" or 4"
 plane back most be used with the wood stone or top of the plank and secured. to it as with 10% or 200 nails depending on thickness of whise
- 4. When Hadi blocks are used frain, length to be 3501, they are to be applied veett one and fush web the and of the be and spixed to the tie using at harm four B² feant spixes using 338² dementer spike holes hored in the field.
- If the alevation change permits, (gill in langth plank biocks chall be used wherever possible.
- 6. Wased shows not exceeding 1" in thickness any he secured neing a standard S" and applies but administring a appeading 1" imast has secured thing sparing 8" track

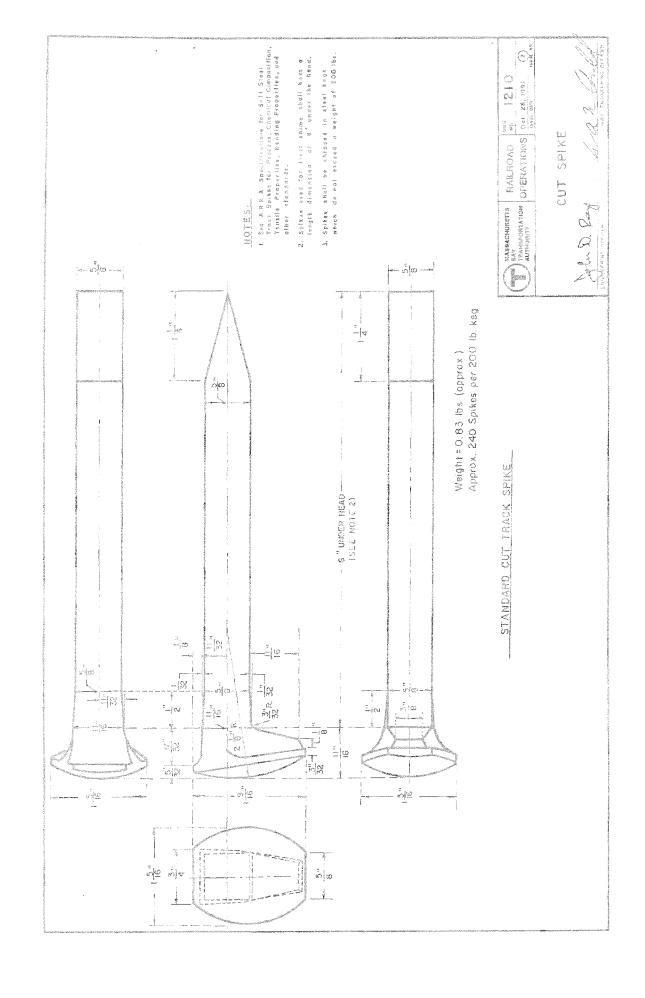
TYPICAL WOOD RAIL BRAGE

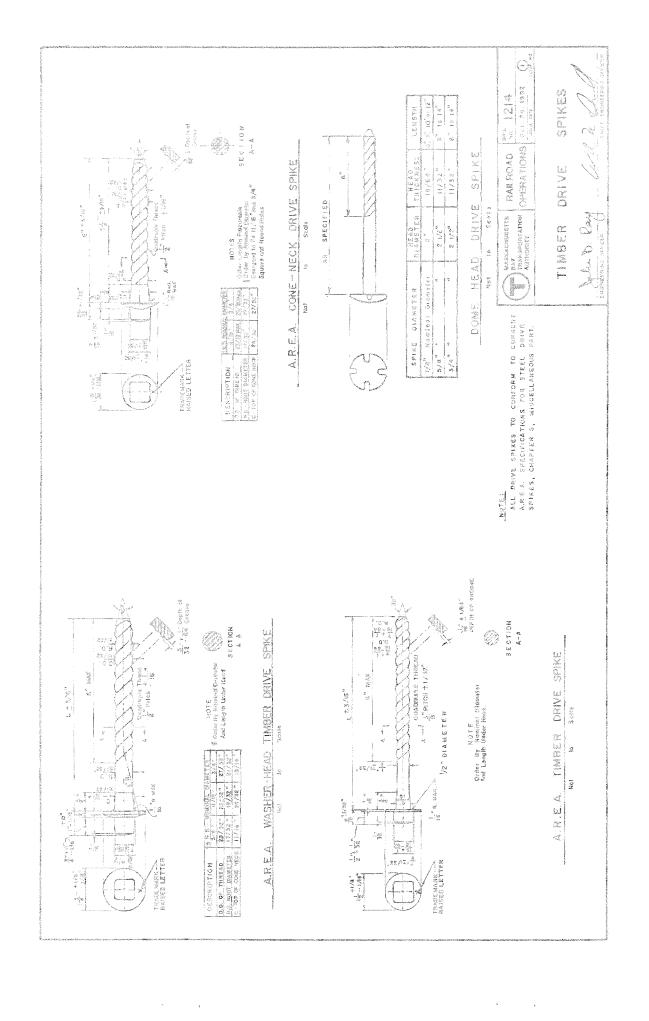
- When a radio blumped man than 1427 it must be securely breded at least every third tie for the full length of the shierming.
- B. Blaccel anders absorbed track should be checked topic offs for slightness to sage and croke fove as well as to assum that the bascus and/or broke are light.
- 9 R encord be substantible shenoing most becard should be considered as one that of hast report in considered has devaluen mismatist punishmens when the
- track bulggrade of fiction and panels) he sourhed.
- $16.\ {\rm Macont}$ of Shandhork includations must be arbitralized in the efficiency above of Years.

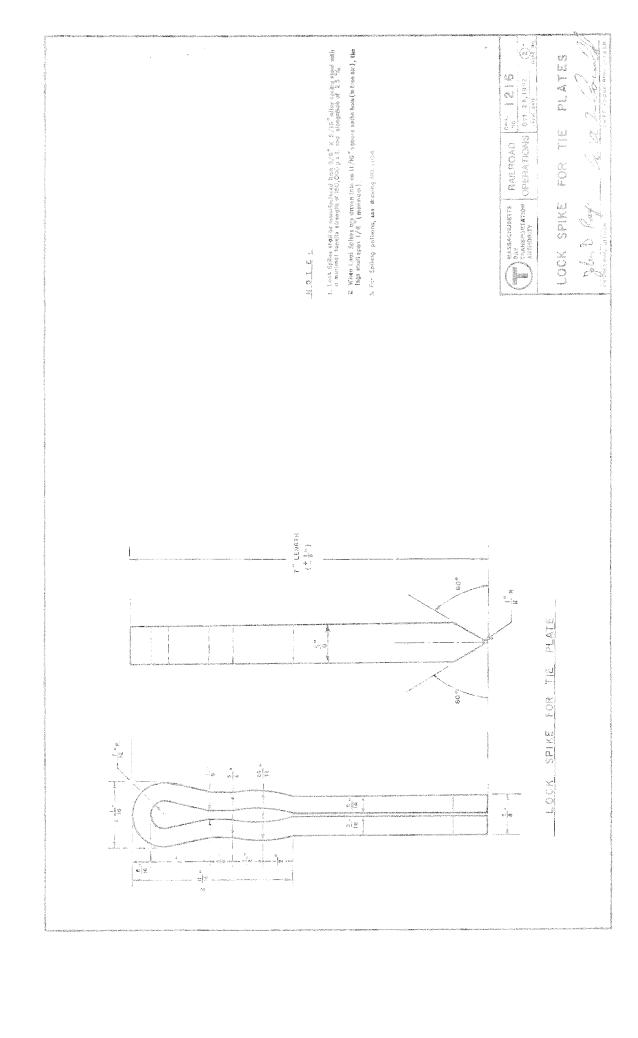


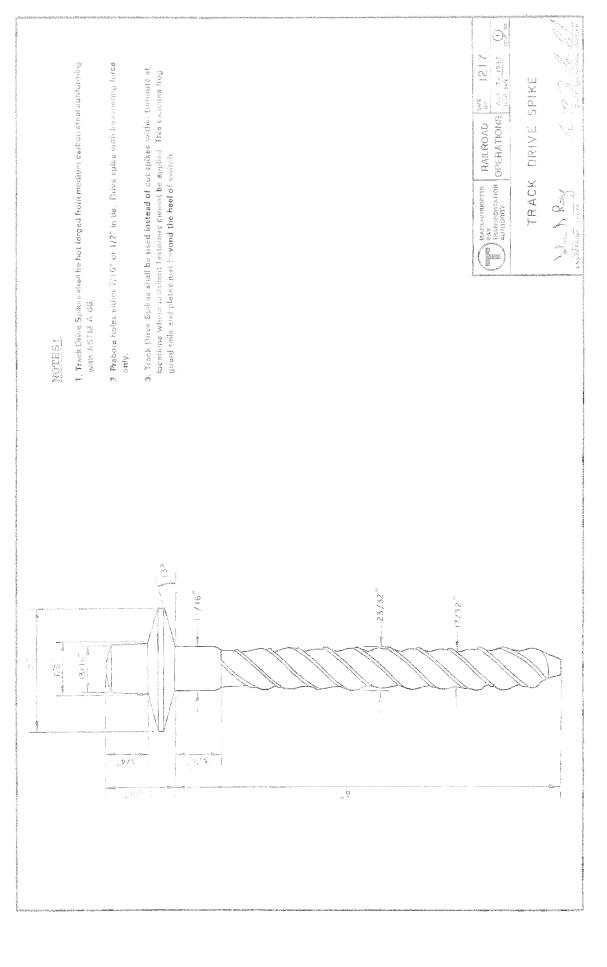
FROST BRACING AND BLOCKING

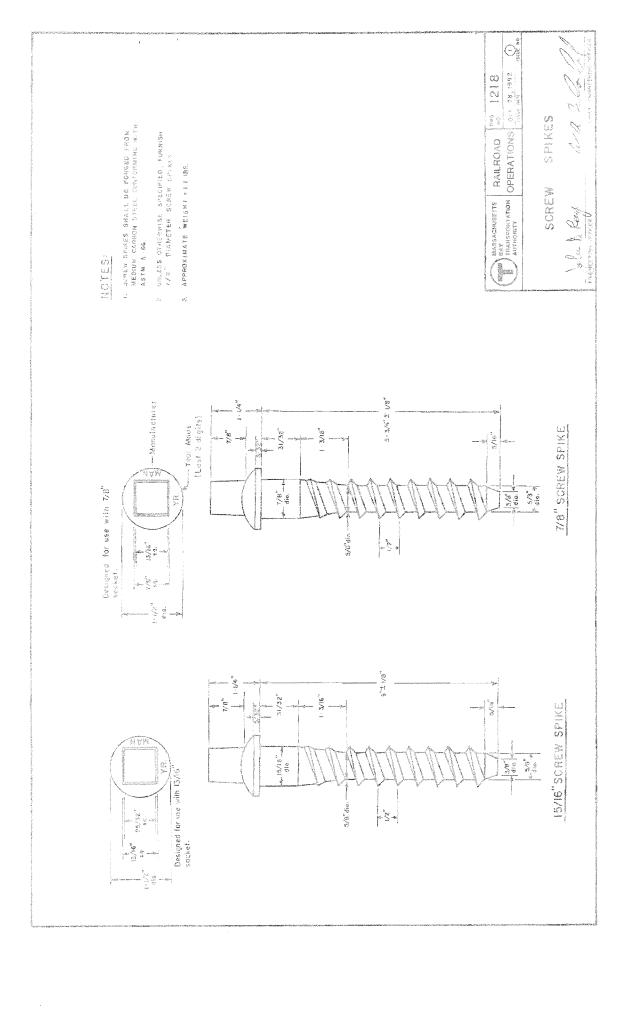
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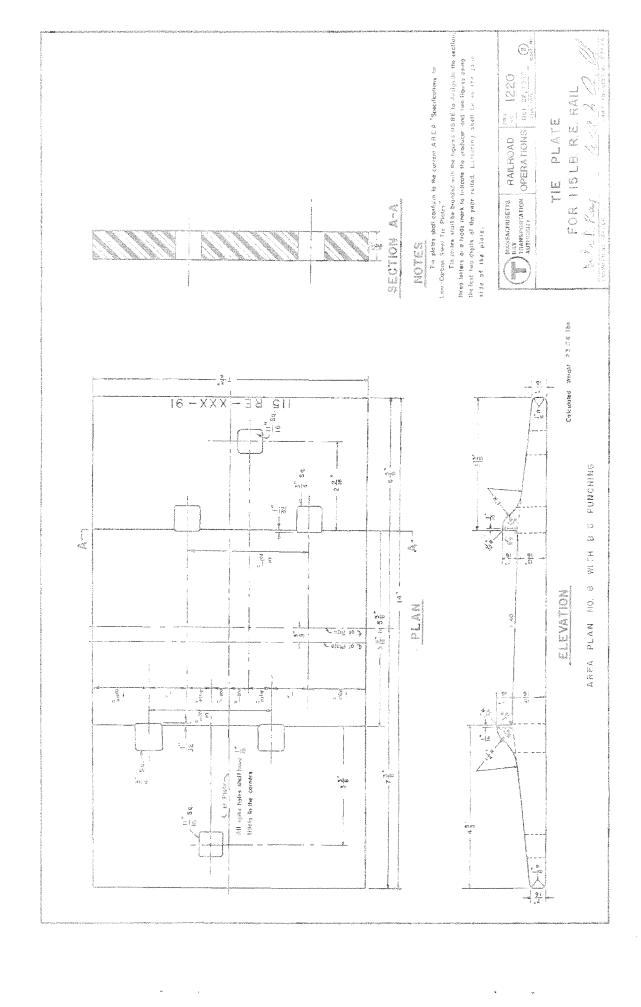


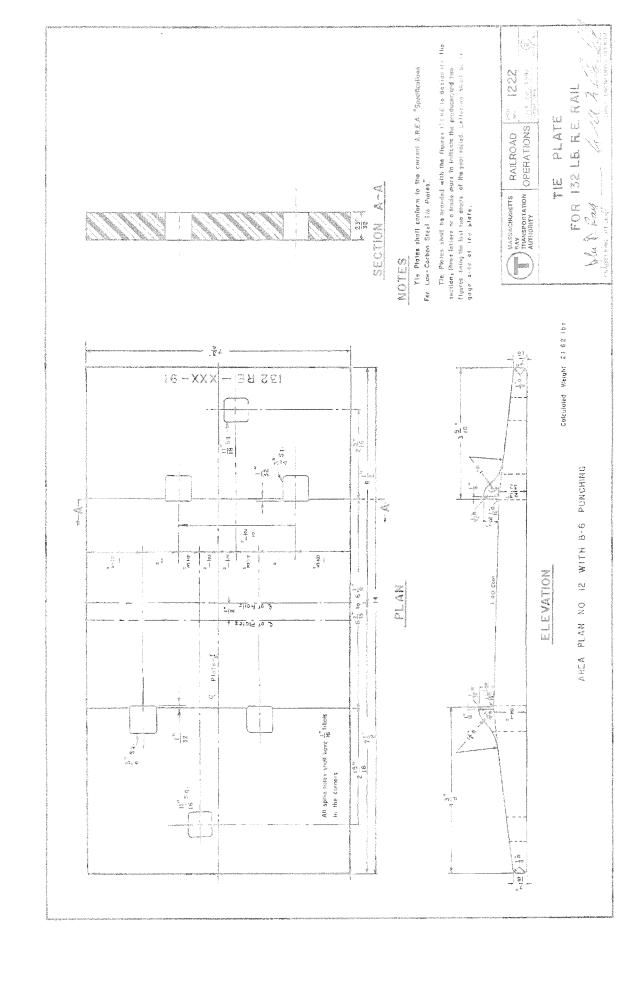


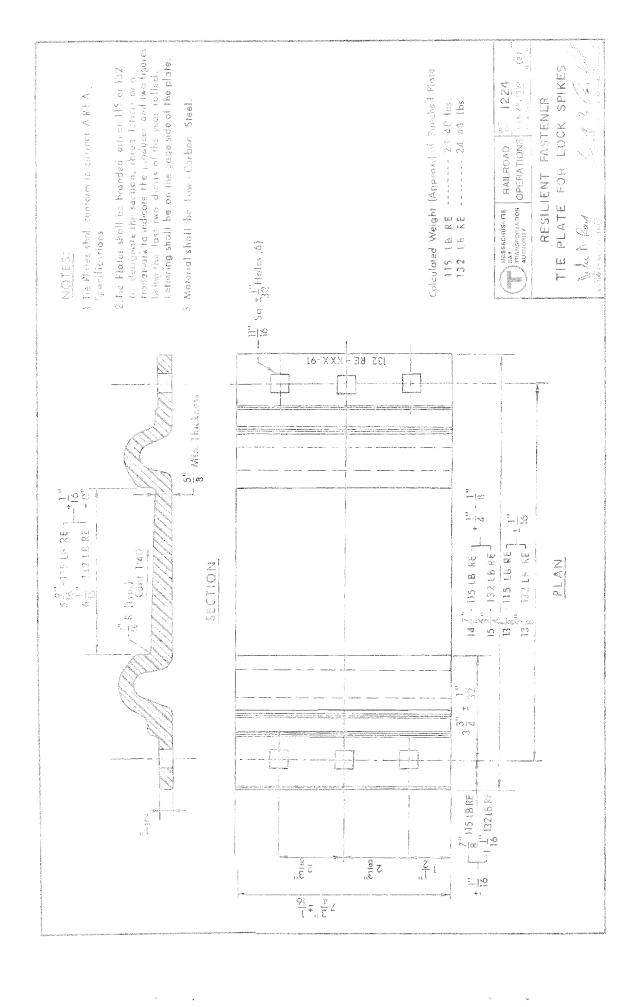


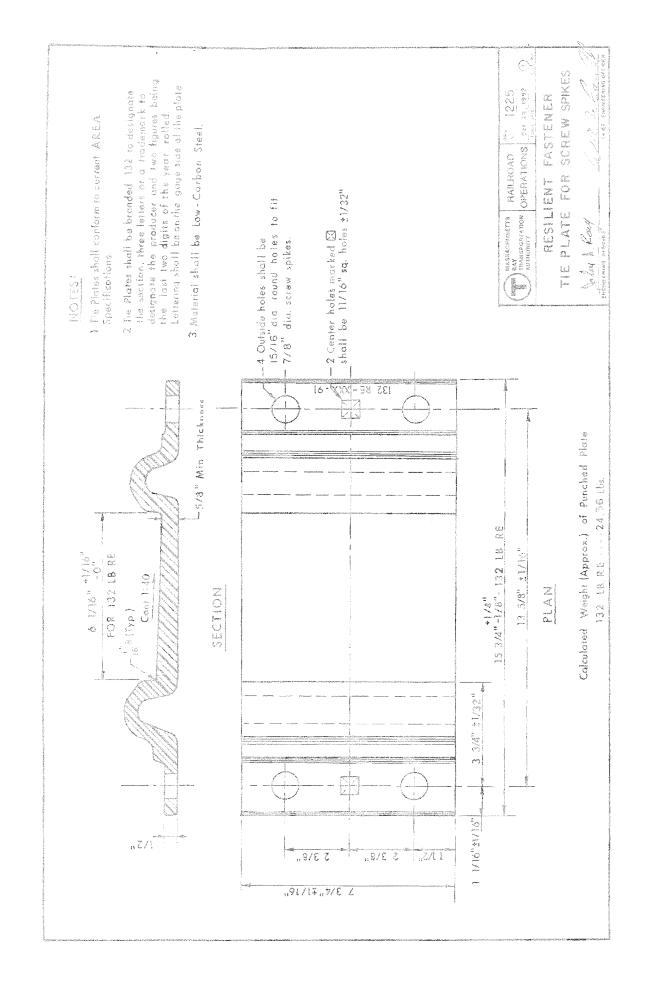


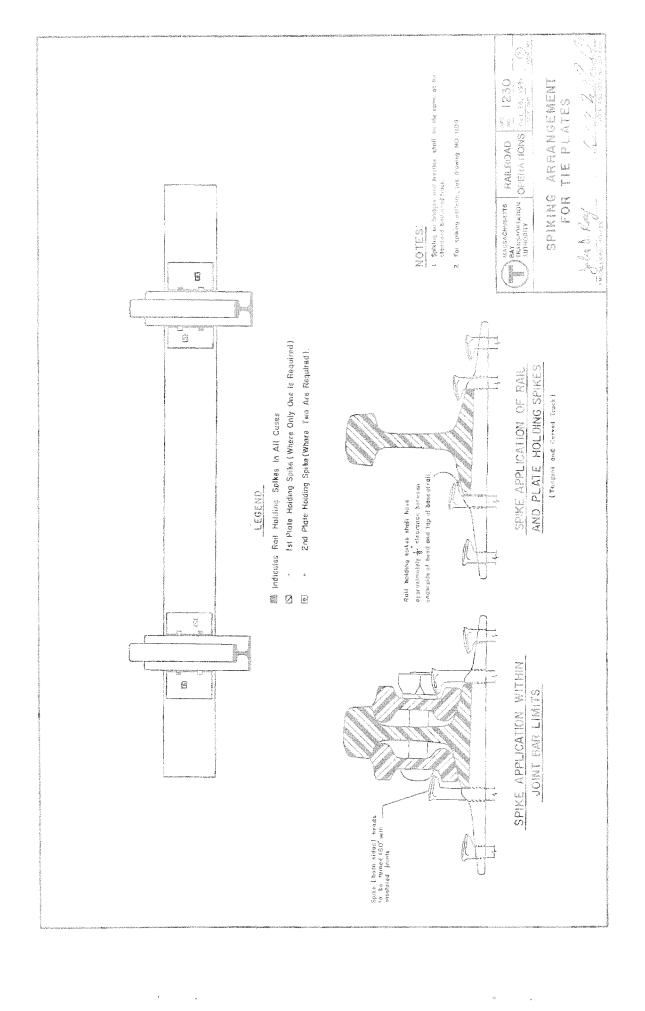


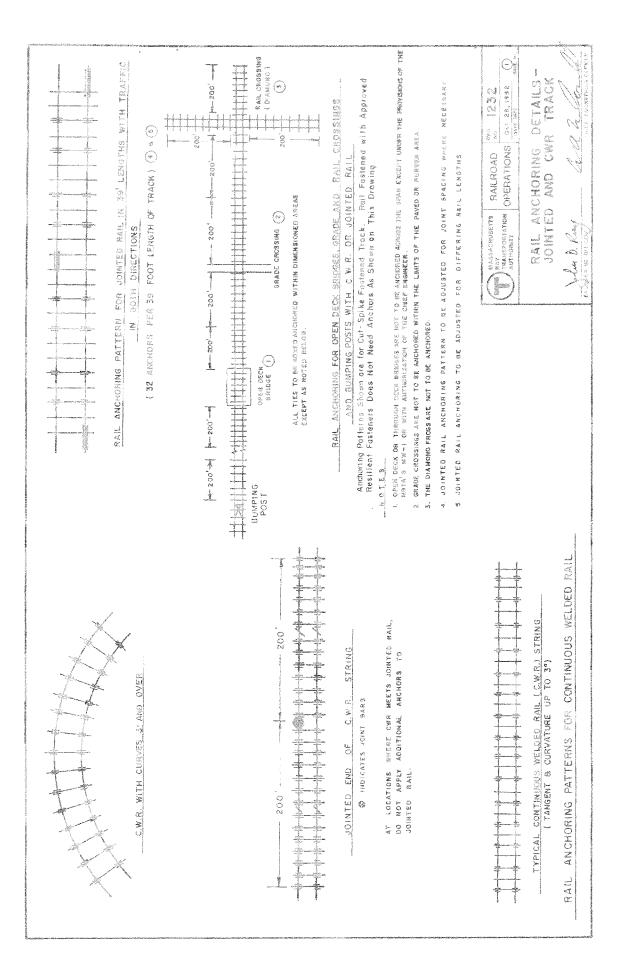


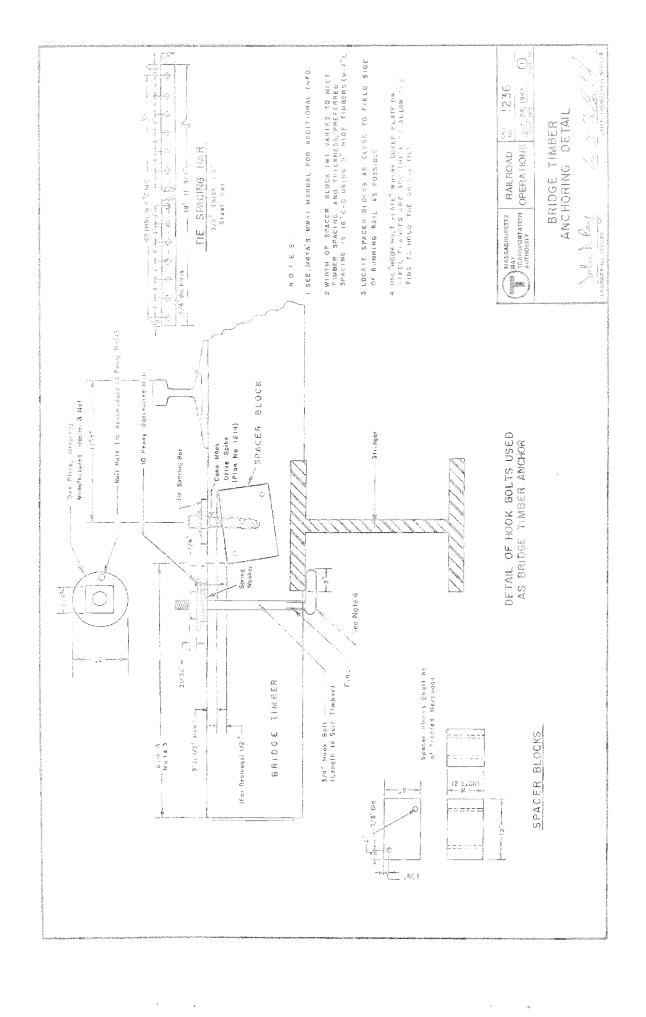


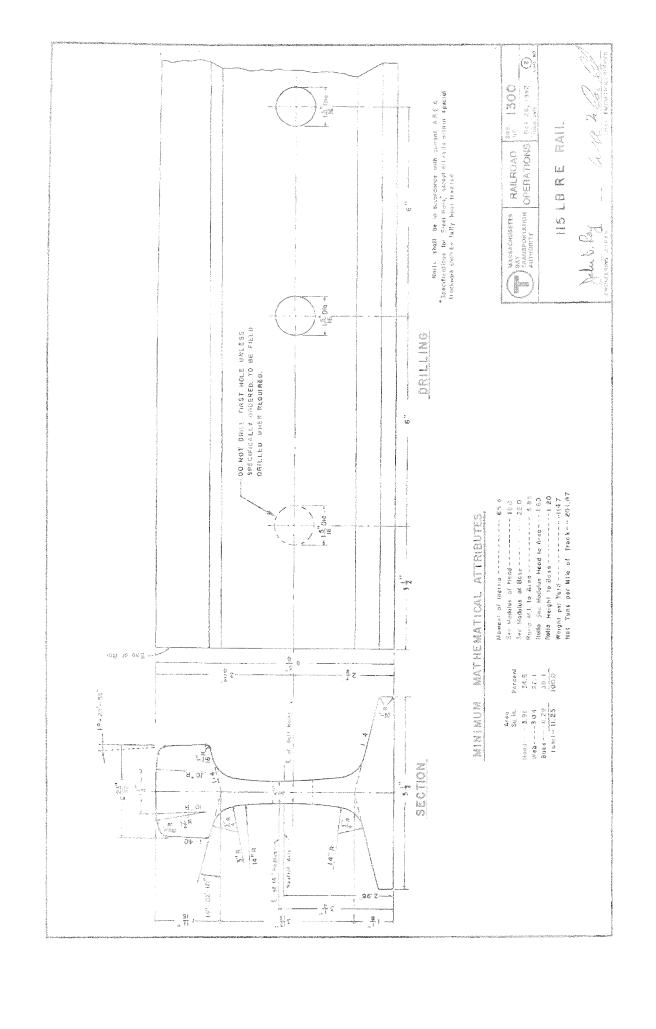


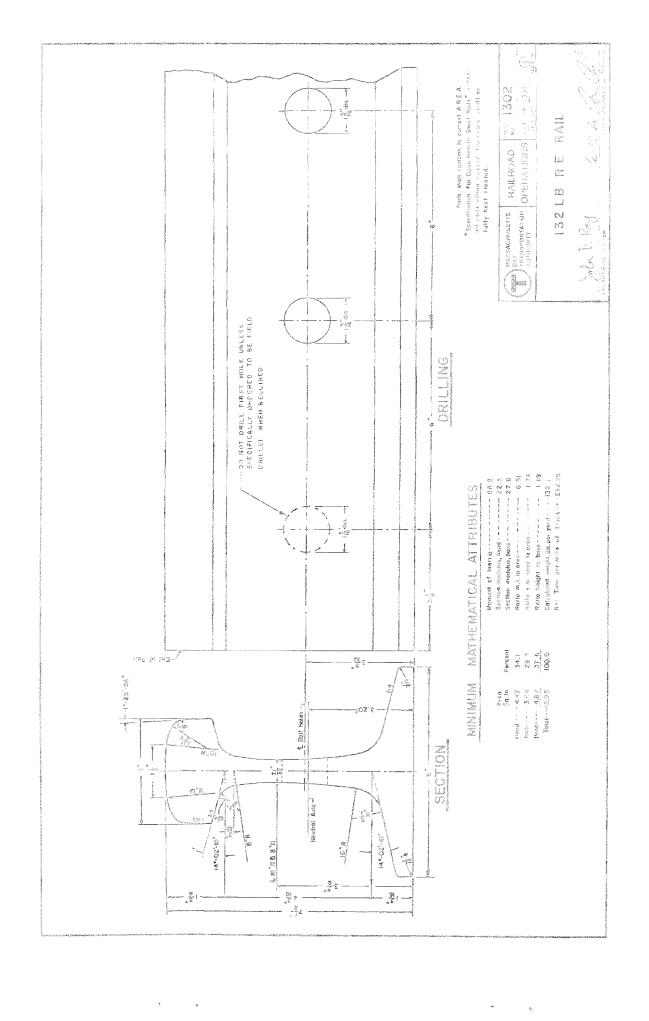


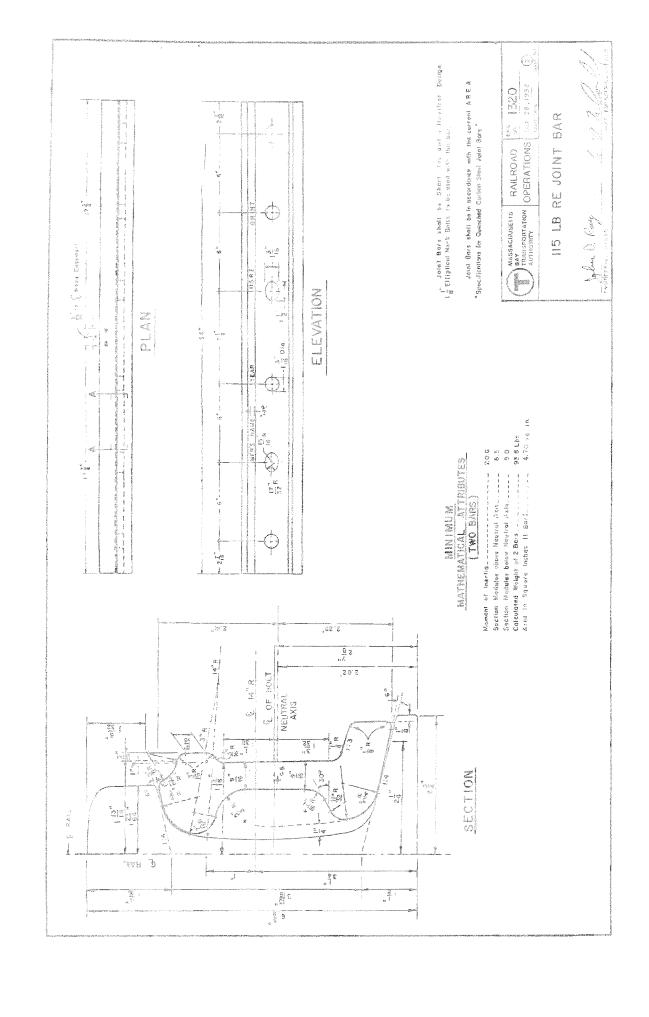


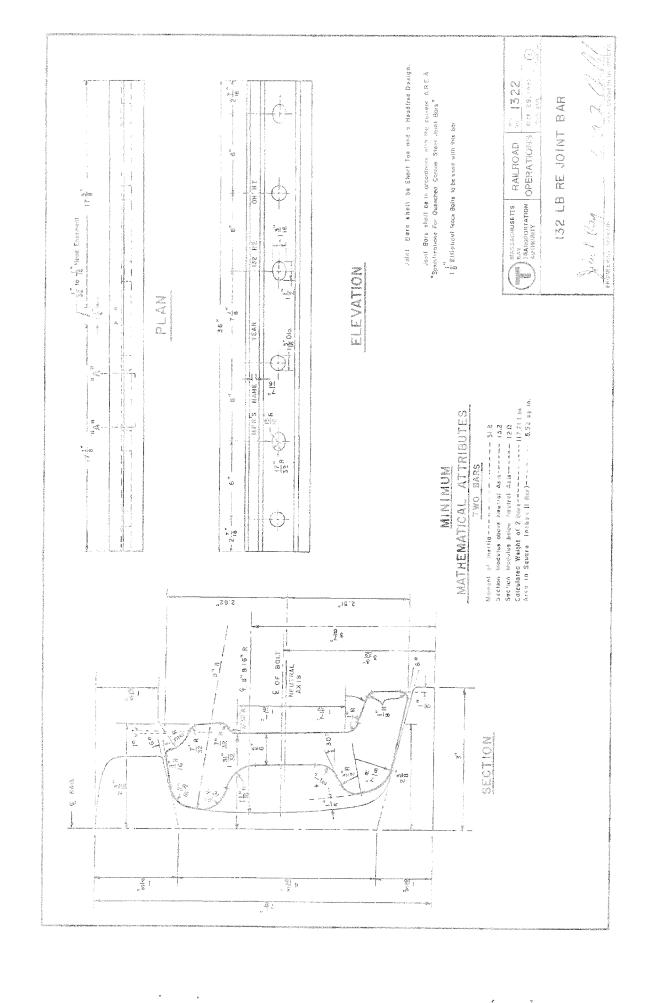


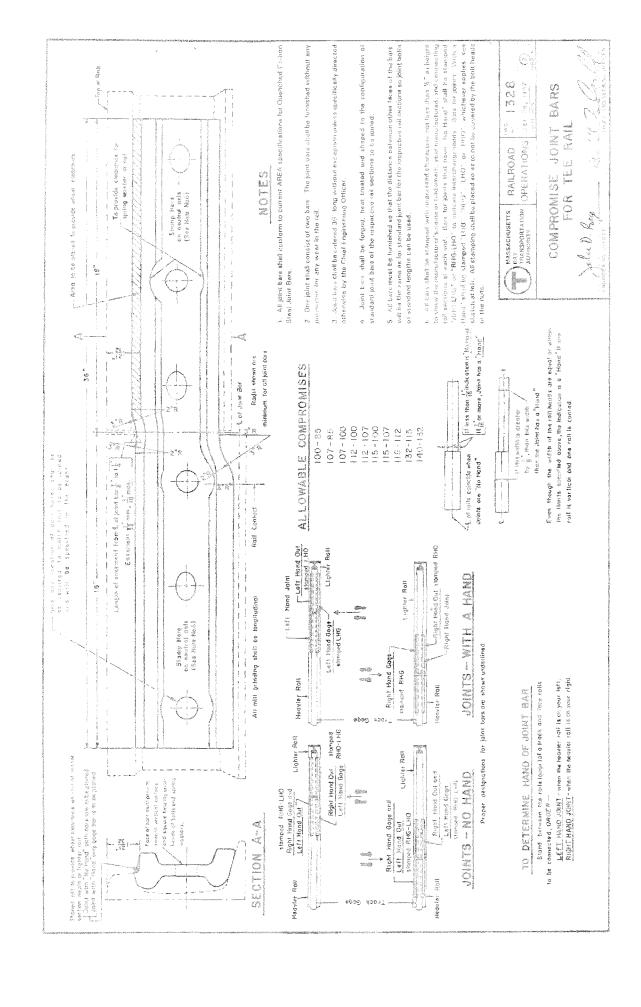


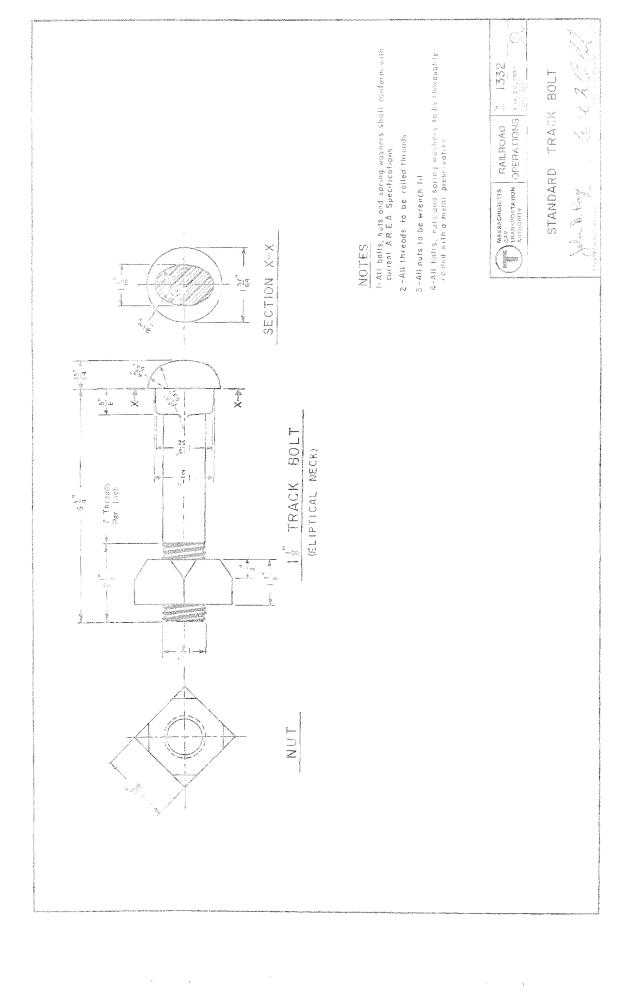


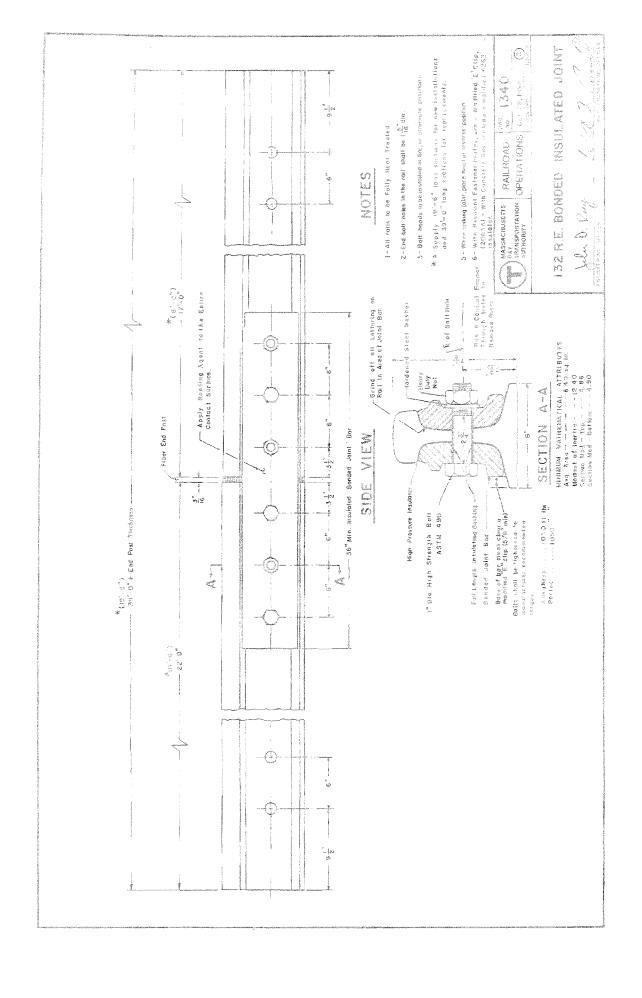


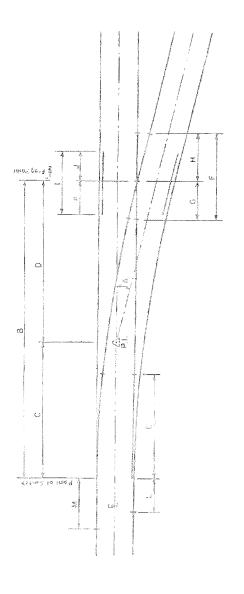












ARE FOR WELDED, RAIL-BOUND MANGANESE STEEL

J: 2 trog point to end of guardinal

K: 2 trog point to end of guardinal

L: Point of switch to end of stock rail

M: Point of switch to end of stock rail

l = Gyard roll length

A i Freg angle B i Actual lead

5	ANGLE						Ž	DIMERSION	~~						
*38%	Ą	æ	0	٥	ш	Ls.	0	I		6 x 6 K	×	ر	2	J	N
Θ,	95-331-38" 67-F" 9'-C" 28-8" 11'-O' 12'-6 5'-1" 7'-5" 10'-0" 3'-8 9 6'-3 1" 4'-6" 6' 8"	11. H = 12.0		38,-e,	.o11	157	S-15	151 151	,0 ,01	3.85		.8	*c2	and the second second	1
αþ	79-29-10" 66'-0" 50' 0" 56'-0" (6'-6" (9'-0" 7'-0" 11'-0" 10'-0" 6'-8" 6'-3" 1-5' 6'-3"	99 99	ر آي	O- ,8%	.9 .91	**************************************	,0	,0 - ,=	10,-01	*- 5:4 #-	# _£ -, 9		in the		
ō	52 - 53 - 54	****	39'-10	47 5	1. 12	53.10	-	1.8 - 8.1	087,81	200	15 	9-3	. 5 . 9	4	10.8
- 1	. (AC) - (SP ~ , 2)	10 per	95.8 4 374 677	- I	(\$) si.	8-,98	*	**	100	3,4-4,6	1.1	.0		5.0	100
o?	30 (8-31-9) 154-62 58-65 95-0 639-0 54-2 (3-1 21-1 18-3 19-4 7'-4) 6-4 6-4 8-7 9-0	154 - 62	- Jac - Ja - Ja - Ja - Ja - Ja - Ja - Ja - Ja	0.56		342"		1	.5.2	E3	1, 1, 2	*		z_100	80-,6
© Requires spec	O Requires special opproved	provei										100 A	SOLIU EEL BUXCK TURROUTS	I I	FLOATING ZEL BLOCK DRINGUTS

(3) Corved Switch

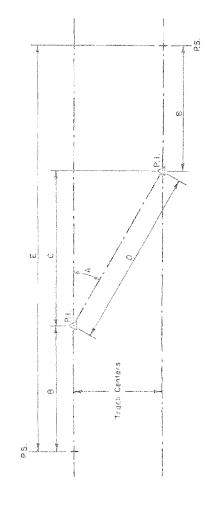
STANDARD TURNOUTS

MASSACHUSETTE HAR.ROAU CO. 2000
AUTHORITOR OPERATIONS (551 -2.19)2.

(E)#

STANDARD TURNOUTS GENERAL LAYOUT

3000 the Stines and the



		an Promision		ن	gpaneen		0			لغا	
TURNOUT	ANGLE		3	Track Centers	un.	Tro	Track Centers	9/5 4	Ţ	Track Centers	in.
NUMBER	₹	Ø	12'-0" (3'-0" (4'-0" 12'-0" 13'-0" (4'-0" 12'-0" (3'-0" (4'-0"	(3,-0,	14'-0"	.50°	13,-0"	1.0-1.0	.0-,21	13,-0"	14'-0"
9	$9^{0}-31^{'}-38^{''}$ $19^{+}-0^{''}$ $71^{'}-6^{''}$ $77^{+}-5^{1}_{2}^{''}$ $83^{+}-5^{''}$ $72^{1}-6^{''}$ $84^{+}-7^{'''}$ $109^{1}-6^{0}$ $115^{1}-5\frac{1}{2}^{''}$ $121^{1}-5^{1}$.0~,61	71'-6"	77-52	83-5"	72'-6"	78'-62	84'-7"	.g-,601	115'-5"	121'-5"
æ	7^{0} , 10° , 10°	30'-0"	\$5.72	3.71.			104-41	115,-2ª,	155'-72	163'-74	171'-63"
0	5° 43" 29" 29" 104" 119" 87" 129" 81" 139" 13" 120" 35" 130" 35" 140" 41" 179" 515" 189 55" 199" 55"	29°-(0]	119'-87	129-8-	- 123 - 621	120'-3\$"	130-38	140'-4!	179'-5!5"	189-58	199'-5%
5	15 30-49'- L6" 39'-113" 179' 93" 194'-93" 205'-33" 160'-23" 195'-23" 210'-23" 259'-94" 274'-83" 289'-844"	39, 11 8	\$6.621	194 - 5 S	208-182	180-25	<u>ರ</u> ನಿ. ನಿ. ಪ್ರತಿ	210-2 5	259'-9 <u>1</u> "	274'-8 2	इ.स. 8 ७७८ इ.स.
20	20-51	59 - 67	238, 0	259'-10-	279'-3'6	240'-113"	260-2"	280'-2 1"	358'-11"	378-111	388-10 8

FOR TRACK CENTERS OFFER TARE LABORS IN TABLE,

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Do Trock Centere of Sint Angle A

En Olevanies Co 28

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0.100254		614 614	
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	0.00	0.036031	

TRACK CENTEMS MUST BE IN DECIMALS OF A FOOT,

MASSACHUSETTS RALL ROAD ONS 2002
REASON COPERATIONS OF 28 1892
ADTHORITY OF ENATIONS OF 28 1892

STANDARD CROSSOVERS
GENERAL LAYOUT

John D. Rad

TURNOUT BILL OF MATERIAL FOR A NO. 8

Quantity		Plan No.
- 4	Part of 100 Switch Forth, compared with relationship to the factory to the respect of the respect to the respect of the respect to the respec	1012
	Had Brok Assassition of the comments of the co	2336
~	SS-0 Undacut Sica Path	8408
	Insubated Gegs Wicks (189, 1 · G)	7106
a	Ne C Republik Bross Side Plates	21%
19	ho. is advised to brace Tide Plaisso	2106
	kg. I Adjastobie Brace Stde Peaks	30.12
2	No.s. Adjustable Braza filids Plates	2106
9	Rolle Shoulder Slide Figures	2106
417	Sec. 2 Storide Side Fless	2012
evi .	No SH Hael Figure, I RH and I-LH	>106
ēù.	Switch Rall Stops	2330
*	Adjustable Backar Clips for Varthat Switch Bods	2107
20	insulate f ferrical Switch Fods (No. 1 & 2.)	2107
್ಷಣ	Turngut Piotes for uur behind feel af entitch fina S.2 to B. (1 x 2)	5 > 40
12	Reactionsy Easternof Adjustable Rail Grace	700
	No. & Cailbound Mangapasa Steel Frog, Complete	2004
	FT2() 230k Toler Fir Plates	2321
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ı	A CONTRACTOR OF THE PROPERTY O	*
	FTRE Modified Hook Twin Tie Plates	N. Control of the Con
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	NOTE THE PARTY OF	Company of the compan

M. These lisses about he supplied for R by 1. S. de Equitabless Legeral as required

Commission		Reference
3		Phy 0, 240.
and the second s	FREEDS MADE START TAIN TO BE STARTED	
8	10'-0" Manganese Siest One Pieces Guers Ratis	28.5%
	daited, Poly type transited Joint Accessoly	
	13 - 5" Bandad Insulated Jaist Plaz Rall	1340
	29-0 tangths of Felly Ment Received East	1
(3)	Variation Langills of Fully free Tracked Rail Ga follows: 25-0, 28-5, 24-57/8, 23-5 1/4, 21 5 5 5 5 6 7 7 7	- Annual Company
920	LOCK Spices	1216
031	S & B AREA STROOM N.	13.10
369	Resilfent Eastener Spring Cilpa-Type "E"	
	Regallies Fostans Spring Clips Type Madifies de	Total Control
981	Standard Resiliant Fastanar Tia Pleins	1224
:	Pairs of Modified John East Legamettes (there is 2001 July Side flow Bestley Lie 1980) and the Company of Jeint and Deel of Switch 1803 Deed	2203
4	Standard John Bur Appeaublique	1322 or 1320
36	Standard Track Salts with Note and Washers	04 87 87

- * Cut Spikes are furnished by the Installar, Wold Kite (14) to be furnished by the Installer.

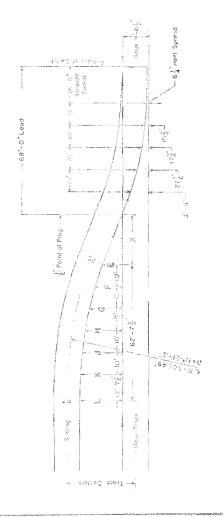
- Tarnoute supplied shall be mither 115 or 132 L.B. RE as piecified in the order.
- 2. Turnouty skull bareaittestly foetsned throughest, escept frog Tie Plaks, found finite and tonations where Series offer councils skysicaly insupied such as an ternout studys soor head
- 3. Fobitionion shall sapply all moths or required for the compilete has billetion of the turnest axion is selectified in the schar.

 4. For Switch Timber 3chedule, see plan 3082.



NO. 8 TURNOUIT BILL OF MATERIAL

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OFFSETS BEHIND THE HEEL OF FROG

	×	W	lk.	<u></u>	I.	>	×	
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	30'-6"	#. -@ -@ - - -	,	11-15 11-15		2 6 77	21 25 26 1,2	2 - 0
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12'-10"	t (10 to	= 04 44 7		# ************************************	ile OL	7.73.1	* ·	- 1 - 1 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2
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20.00	51'-24"		1	6-50	40.7	nle	5 27*** 23* 	- 53
	13-6" 38" 64"	4'-10-4	%'-₩		7-82.	(c)	8'-78"	

Values for track centers hat shawn may be determined by interpolation,

TURNOUT DATA

FROG No 8 Angle 7º 09-10 "FROG DMENSIONS.

ega- or	107.01	. 0 . 361	130
E ERGER	HEEL	1011	0-2
2497	14 P	3,-0.,	2.11"
PROC	3641	200	C7 C7
16.60	SECTION	18, 132	119,132

SWITCH RAILS

16'-6" 1 year -Length ---

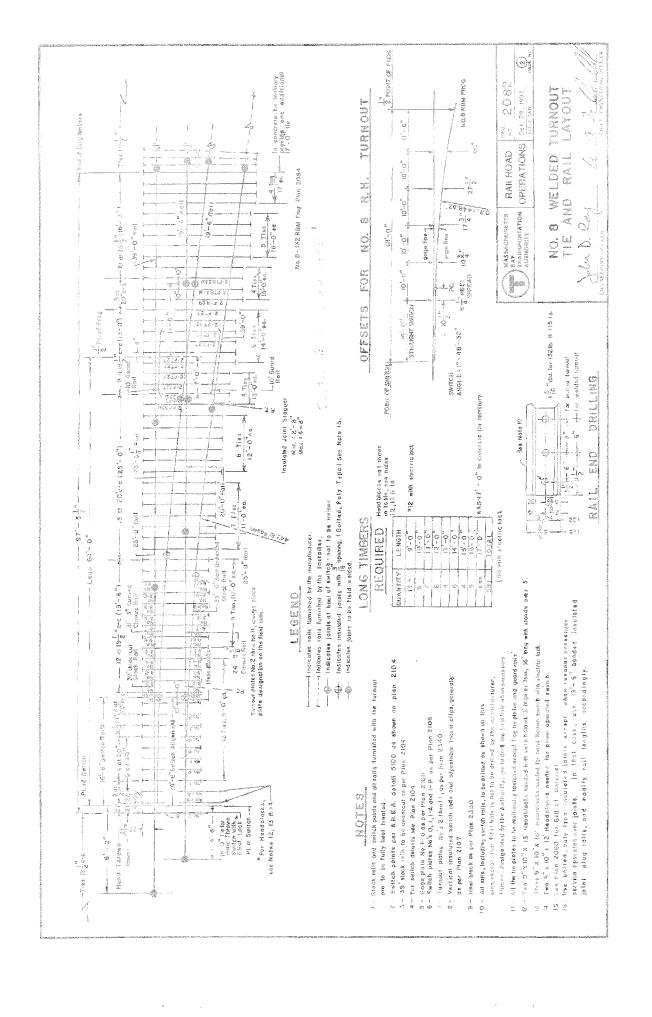
- (2°-52'-08" LEAD Point of Switch to 2 Point of Frog ---- 68"-0" Degree of Curve----

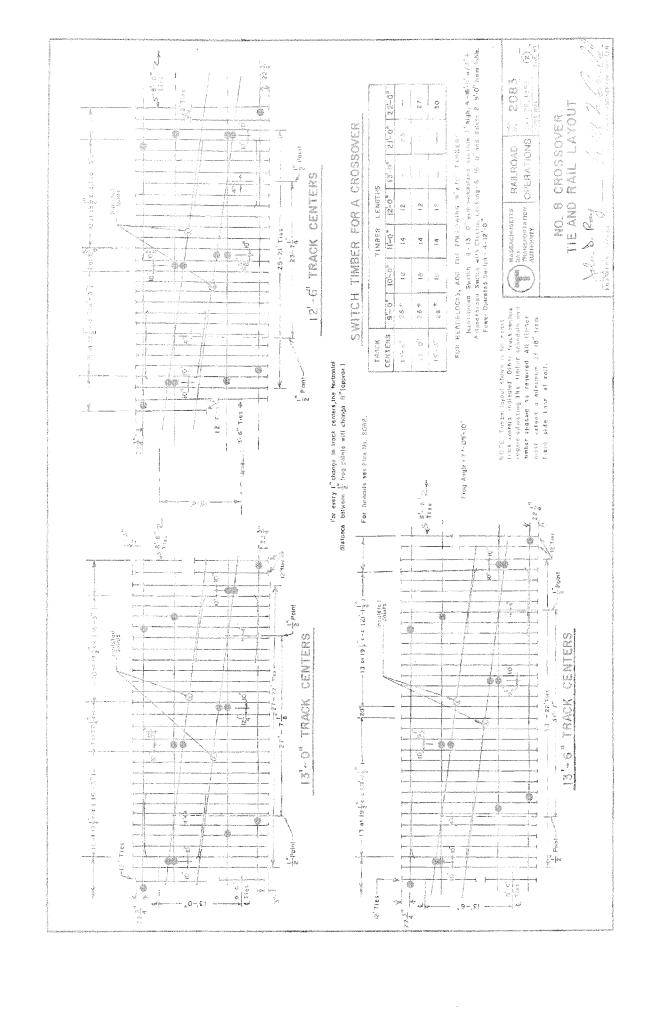
CLOSURE RAIL DIMENSIONS

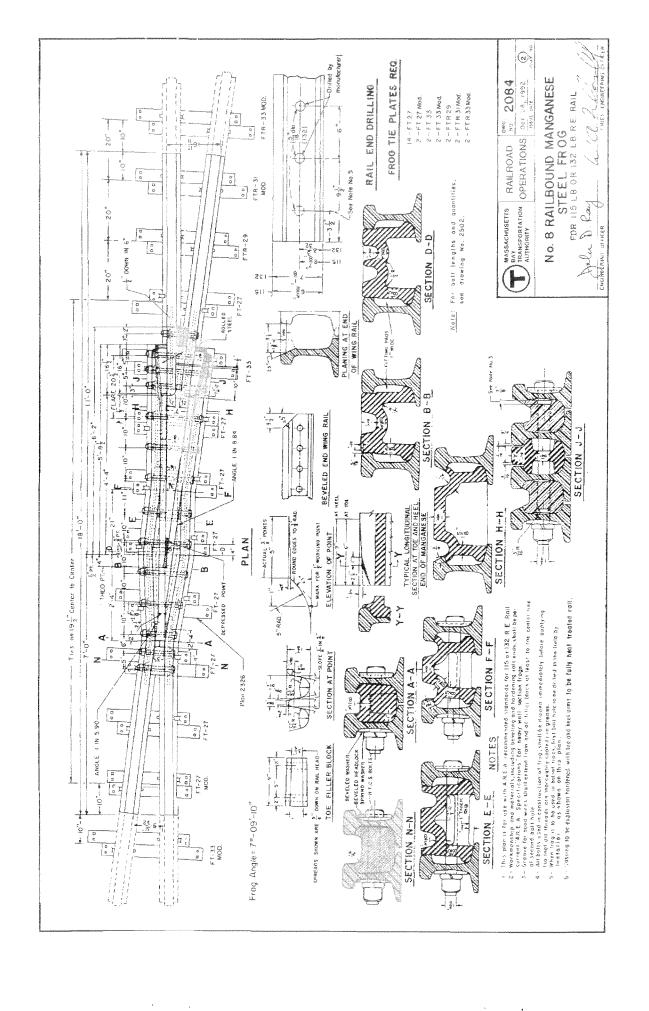
OSURE RAILS	STRAIGHT	445	4817
LENGTH OF CLOSURE RANGE	CURVED	44. 8 15 "	* 1 8 - 1 8 *
FROG	TYPE	200	5.6.
RAIL	SECTION	115 , 132	115,132

OFFSETS FOR NO. 8 TURNOUT IIS OR 132 R.E. MAILS UNDERCUT

Branch and a second







TURNOUT NO. O WILL OF MATERIAL TORA

	(C) (A) (P)	Sign No.
- *	fair of 16-18 Switch Famile, comedate with reserviting here, clips and arous aroches	20.00
rd	enmission, co	2380
- Ac.	39'-0" Undergut Stock Raifs	\$ 0.12
-	fresidetad Sage Flotine (Note C)	2106
N	No. O Adjustable Brace Slice Pictes	2106
7	No.1.A. Adjustable Gruce Sliss Plates	90.28
w.	No. f Adjustable Brace State Plates	2106
2	No. 2 Adjustable Brace Cites Preces	2012
۵	No. 1.P Shoulder Slids Platet	2108
n/	Ne 3 Shaulder Stids Picter	2106
હ	No. SH Peat Pintes, 1-RH and 1-LH	5106
G1	5w/8ch Roll Stops	2300
명	Adjuntabla Rockur Clipn for Vartical Switch Rods	2107
N	Insulated Vartical Switch Ruds (No. 1 & 2)	2107
02	Turnaut Piates for use behind heel of emiton (No. 10-2 to 10-12 s.2.)	2340
27	Restivity Fostened Adjustable Raff torce	\$0 \$0
-	No. 10 Roll bound Manganess Steel Fog, Complete	2105
4	FT2C Hook Twin Tle Police	23.55
9	FT23 " 6 9 0	:
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adiabatic Contaction of the Co	FTR27 Nook Twin Tit Pistes	The state of the s
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Annual Market Control of the Control		Marie Marie Control of
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ſ	FTRZ7 Modified Hook Twin Tie Pintes	- 15
f	FTRES S & S	The second secon
r	man in the control of	100000000000000000000000000000000000000

W These items shall be supplied for R.M., L.H. or Equilotanel Turness as required.

and the second s		
Quantity	Description	Reference Flass No.
63	FIRST Modifies Hook Tean 19 2022	20 00 00 00 00 00 00 00 00 00 00 00 00 0
2	15.3. Marganese Stat One Place Sugged Ruits	2302
2	Bolted, Soly lyge insuloted Joint Assembly	-
-	18"- 5" Banden taxolaned Joint Plug Mail	1840
2	39-0" Leights of Fully Read Forth	Parameter Company of Management Company of the Comp
*4,	Various Lengths of Pully Man 1 180184 Rate of 101 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	many (Christian Manager Control of Christian Contro
20 to 10 to	Lock Spikes	D N
100	AND	01.01
450	Resiliant Featener Spring Clips - Type 12.	
9-	V	· ·
-78	Standard Realitent Fosters 7te Pictes	122.8
Control of the contro	Fork of Reddilled Join Bor Assemblies (Head & Tor of Case Side Born forces and to Alton Switch Morament of Join hear Hast is Switch No. 20 only)	3022
5	Standard Joint Bar Assemblies	1322 or 1320
59	Stondard Track Solis with Nuts and Weathers	04 17 17

- * M Car Spikes are furnished by the Installer.
- * Wold Kits (16) to be furnished by the Insteller

Notes:

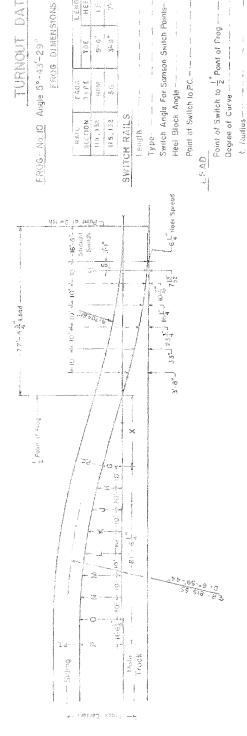
- . Throuts supplied shall be sither 115 or 132 LB RE on specified in the order.
- 2. Termants shall be resilianity testened throughout, except they for the many for the man where Energy (Siper Conference Sund Ania and bottlens where Exemples they connect be physically takeling buth on on termand before
- 3. Fubricelor shall supply sit material required for the complete installation of the furest except switch limber usings afferings specified in the erder.

4. Far Switch Timber Schadule, see Plan 2:02

RASSACHISETTS RAILFOAD 201 26, 1992
AUPSORITY OPERATIONS 021 26, 1992

NO. 10 TURNOUT BILL OF MATERIAL

L. M. Z. L. L. John D. Pay



FROG	
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OFFSETS	
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a.	7'-52'	1 2 L	7- 8-7	7.	61-12	-le:	-,0	- 1,-	B
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de la companya della companya della companya de la companya della	6-10 t	#10 7.2	7-2-1	-10-10-10-10-10-10-10-10-10-10-10-10-10-	7,-643	7'- 8-7	1,0-1	20-8	8-2-1
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>	**************************************	0 10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	18, US	5-73	3 60 -	50100 IIc			1 6 2 - 3
ongen Line		4				1-10			2,-14:1
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×	3.5 - 2.5	34'-11 2	36 . 736		39'-11 8"		-12,-124	44.11.3	- 1- 5 1- 5 1- 5 1- 5 1- 1- 1- 1- 1- 1- 1- 1- 1- 1- 1- 1-
THACK	12-2"	12-4"	15-6"	-0 -2	12-10	-0-2	2-2	13-4 E	10-10

Yushas for trock centers not shown may be determined by interpolation

TURNOUT DATA

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	30.1	, 9 - 35	i sa
7,500	4d 5d 5c 5c	×35	୍ଦର
RAIL	SECTION.	11.0	115, 133

--- 1 *- 48'-32" - Same As Switch Angle .16°-6° Stroight Type: Switch Angle For Samson Switch Points - Sart

" 19'-7"

-77'-43" 706,965

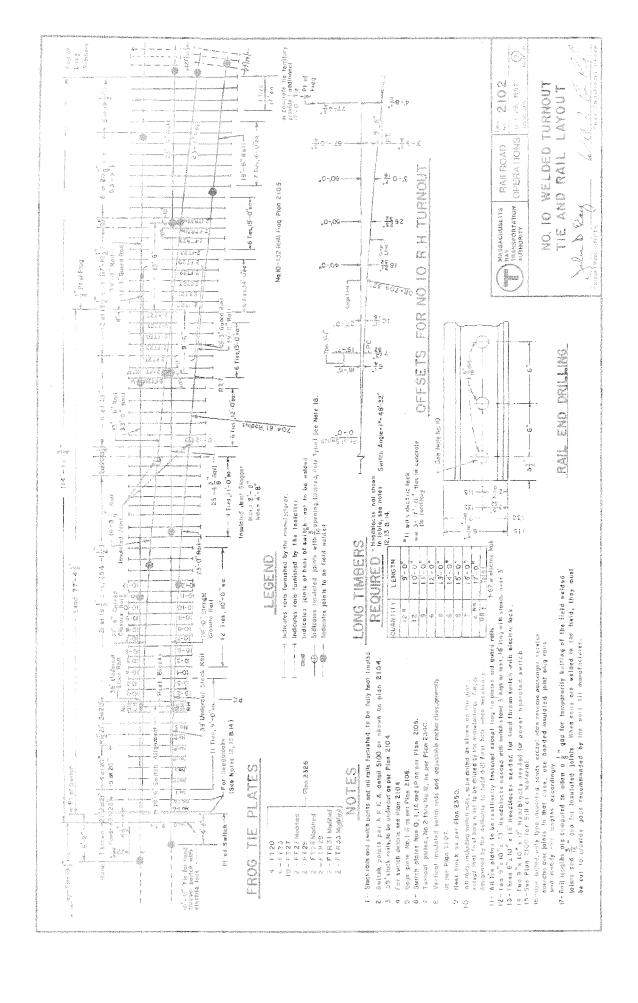
CLOSURE RAIL DIMENSIONS

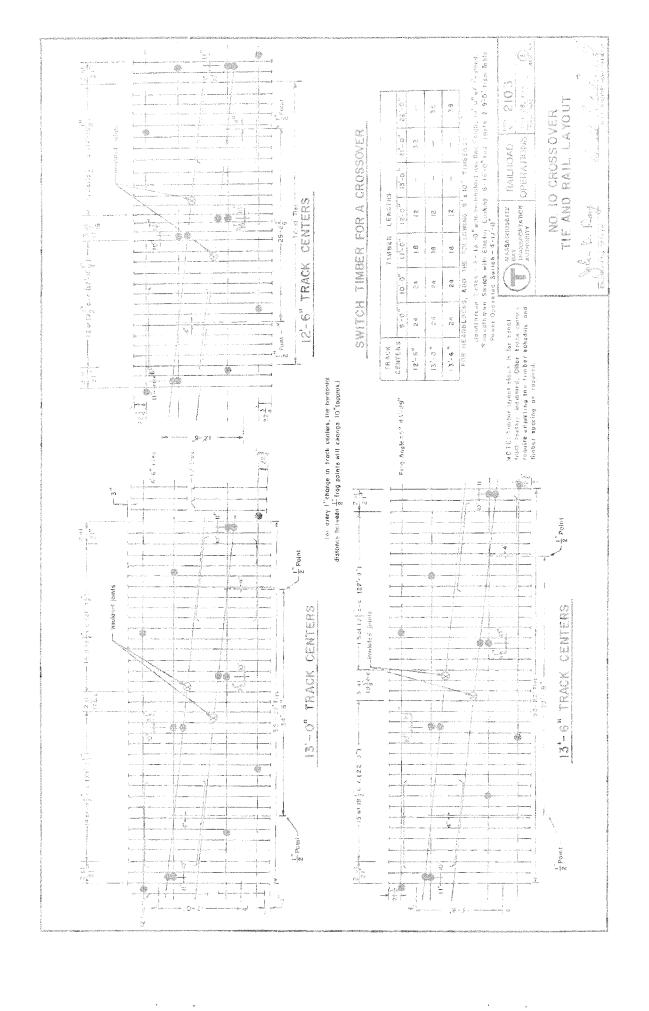
OF CLUSURE RAILS	STRACHT		577- 12	addination of the state of the
	CURVED	3-1-6	57'-3 1	Market School Control
FROG	TYPE	Reta	9.8	
RAIL	SECTION	115,132	1.3, 132	from contrary or ampaged

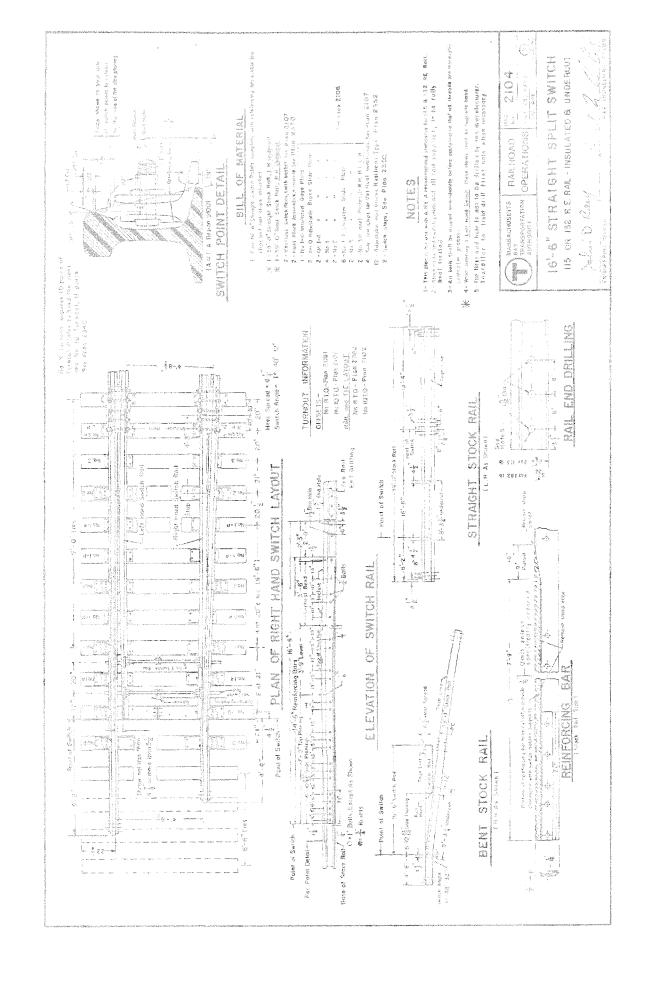
MASSACHUSETTS RAILFOAD WS 2101
TUTALFORTON OPERATIONS NO 17, 1991

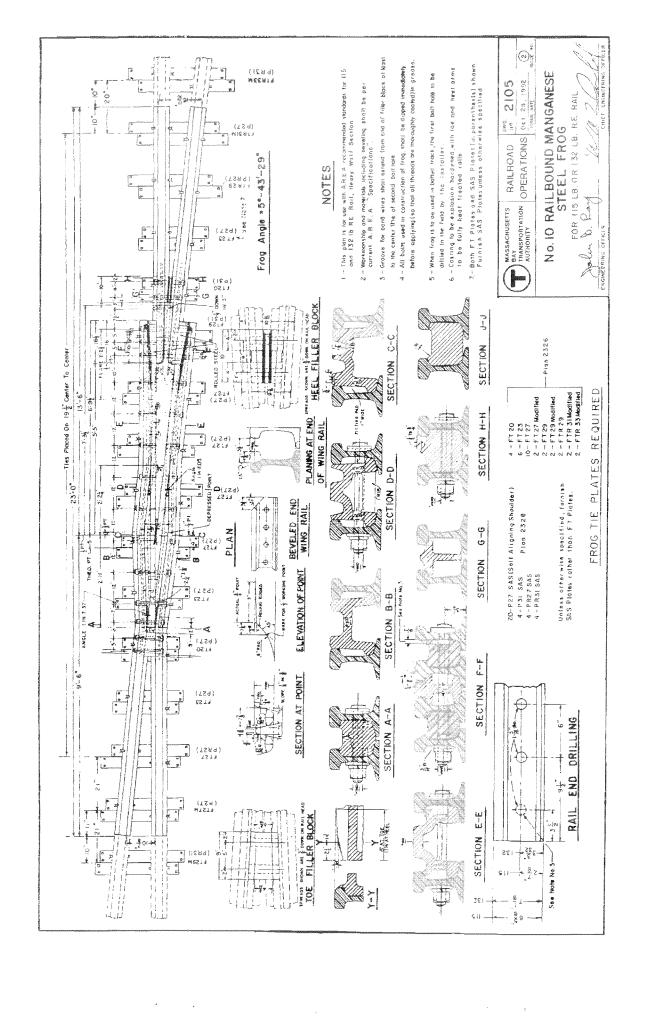
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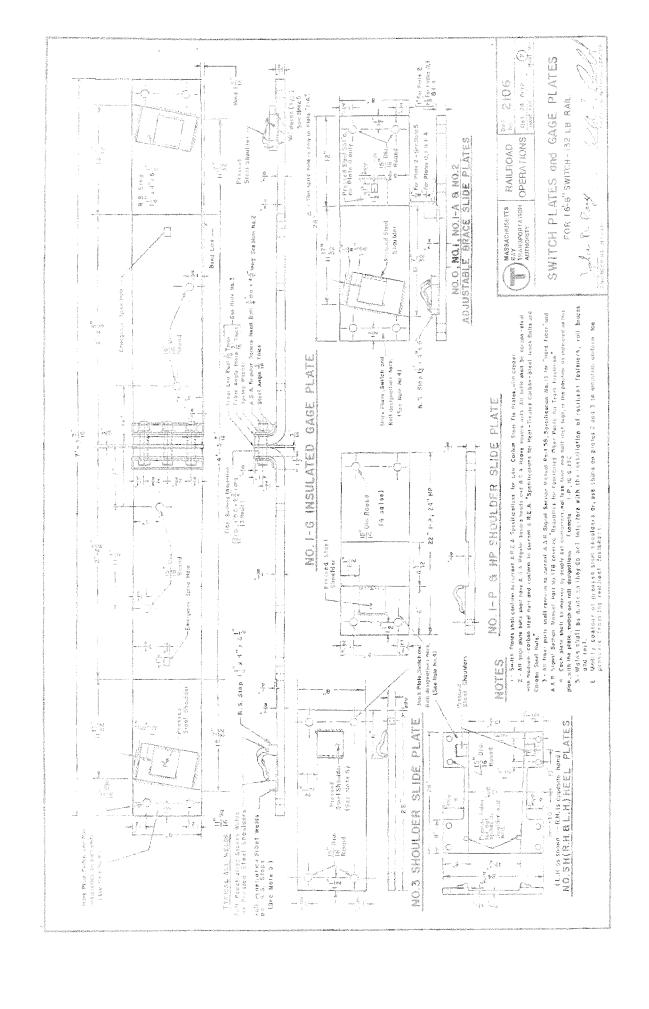
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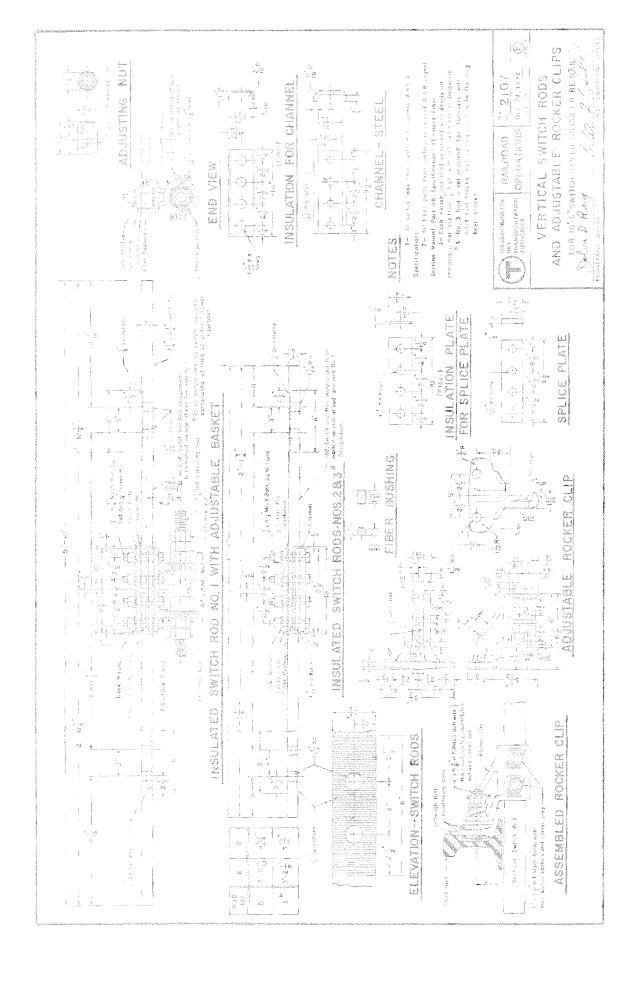












NO. 10 TURNOUT WITH FLOATING MEEL BLOCKS -- BLL OF MATERIAL.

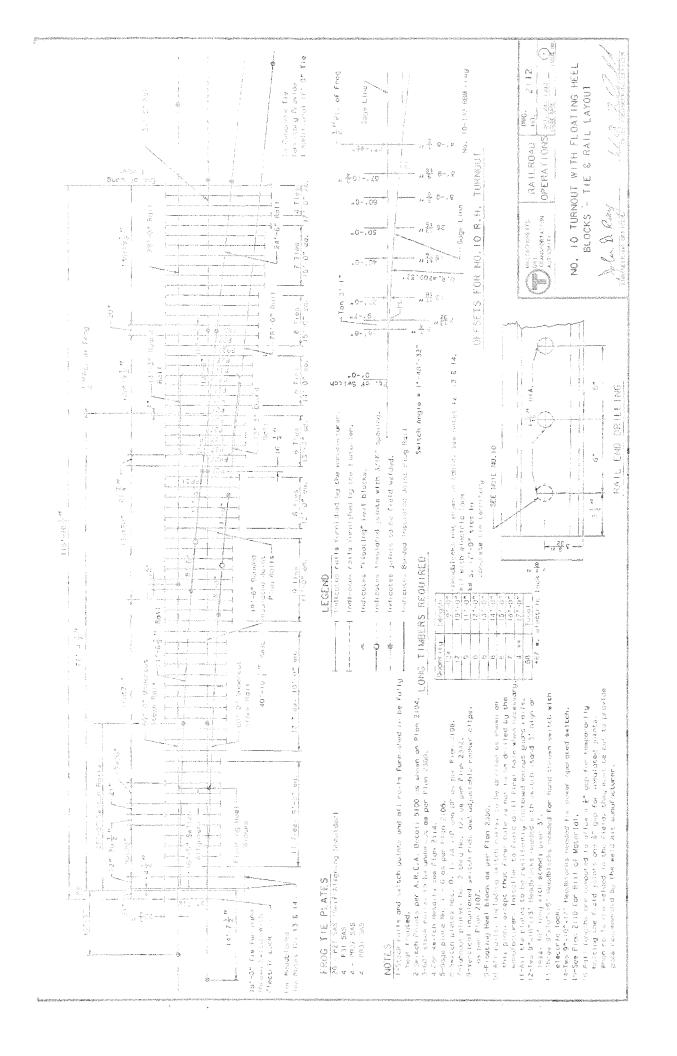
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4	139, PACE SELECT ALTOMORS SHOWING THE PLANS.	9244
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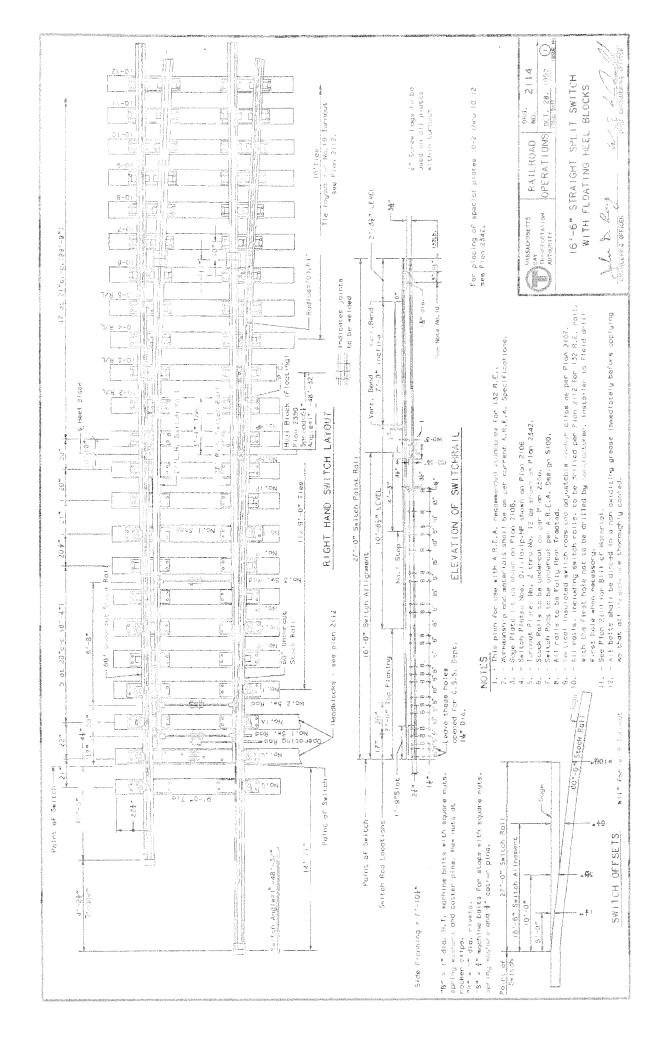
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RAILROAD P.C. 2110

NO. 10 FLOATING HEEL BLOCK TURNOUT BILL OF MATERIAL

San D. Ray





KJ. BILL OF WATERIAL FOR

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~	We. 2. Sabulaer Citus Pigins	72° 20° 84
C-1	10.2	72.0
2	No AM (1881 212(88), 11 MM 23.0 [18.3]	7:27
*	Switte Roll States	2 3 3 0
63	Adgratusing Bocker Cings for Varifical Switch Roas	2150
eq:	Inauletes Vertices Switch Russ (No. 1, 2, 5 & 6)	2.58
\$ 2	Turner: Plates for use the brack break at switch (19.2 to 20.5)	0.453
2	Resissionly Ferbened Adjaceshie Roll Bruce	2352
	No 15 Noilbaund Manguessa Steal Fress, Complete	9617
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W. Thank House sholl be ourgined for R.M., L.M. av Equidateral Turnford as required

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And the second of the second o	PFRL Meditle den la lain l'e Malace	9272
	1.5" - 3" Mouganes attack Prince Prince Conference	2350
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	Paris of Destroy Court Bas Assertives (Rest & Esso) books de Batter Na Orace)	2012
54 (%)	Stands dam Mer Assembles	1322 or 1320
6.9	Signafard Track Bulls with Mule and Washars	332

- # % Cari Spikes to be faretaked by the Installor.

 Weld Kite (22) to be faretaked by the installor.

 For Equilateral Turbout, closure rais have slightly different lenghts, See Equilateral Drawing (2153).

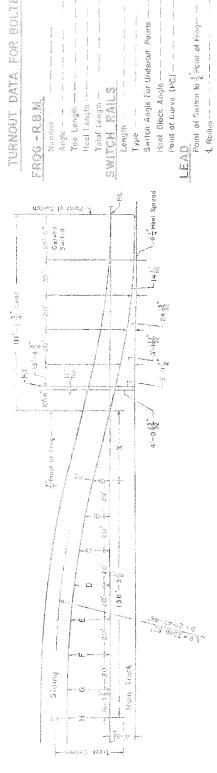
Notes:

- 1. Turnyals supplied shall be sither 115 or 182 L.B. RE as spacified in the order.
- 2. Tyrocutu aboli be rasilianliy fastened ibraughbul, ercesi Frog Tie Flatsa, Geord Aglie and locations where Survey Cips constitute he physically invialled such as no lumani plates page had.
- Cobractor shall supply all bater of equiral for the complete institution of the tracul except switch timber unless otherwise specified in the order.
 - e. For Switch Timber Schedule, see Flux 2152.

MASSACHUSEITS RAIL ROAD 625 2150 18.457 18.4

NO. 15 TURNOUT BILL OF MATERIAL

Section 18



OFFSETS BEHIND THE HEEL OF FROS

TRACK	×	4	<u> </u>	<u></u>	Δ	ш	ŧL.	O	I
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MOTE: VALUES FOR TRACK CENTERS NOT SHOWN MAY SE DETERMINED BY INTERPOLATION.

TURNOT DATA TOR BOLTED TRACK

FROG - R.B.M.

MS (30-49'-08		: \$-,5:	#B-92	.0 792	Curved	On441-47"	10-321.57	At Switch Poin
Section terrorise terrorise annual contract of the Section of the	ADDE on the contract that the	Too Length	Heal Langth	Total Lingth	Length	The second secon	Switch Angle For Undercut Points	Heal Block Amyle	Pout of Curve (PC)

1- The lines of the diagram indicate gage lines.

-- 3 *- 05 - 30 " 74'-103"

75'-0"

Length of Curved Closure Roll --

Degree of Curve ----

Lungth of Stroight Chosure Rail --

2-For details see the following plans Switch - 2155 or 2165

Froq-RBM- 2156

3-For welded turnessits see Plan 2152 in 2282 for offisets helwest the paint of switch and the toe of frag.

RALROAD C 2151

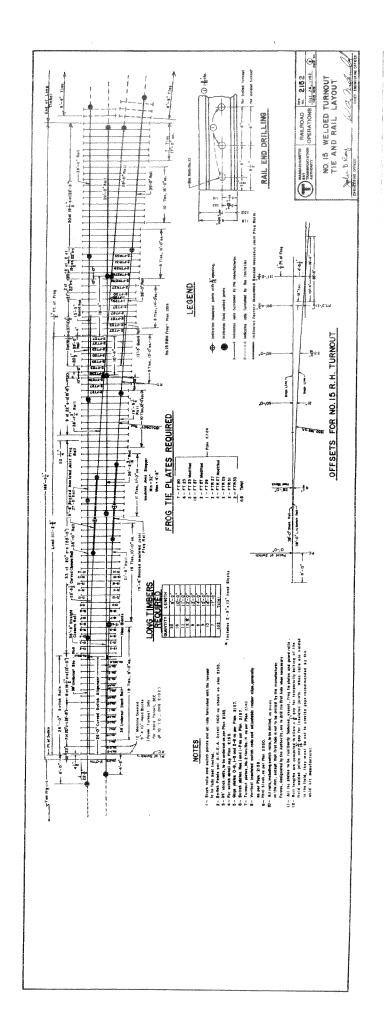
RALROAD C 2151

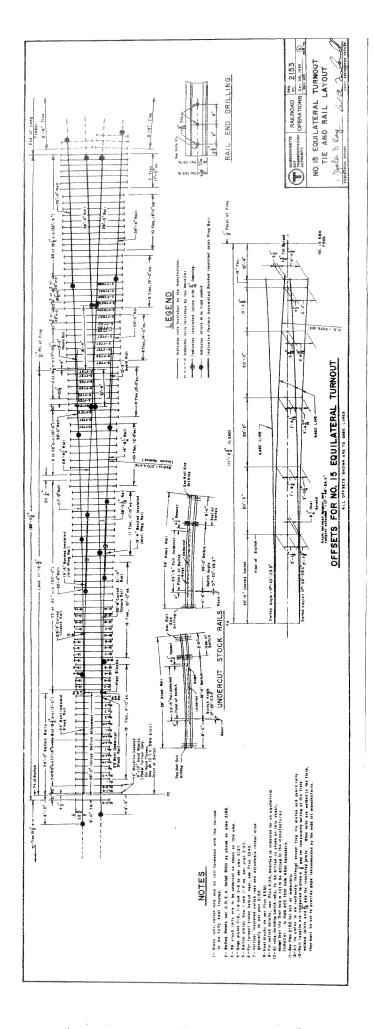
AUTODISTA

(E) {

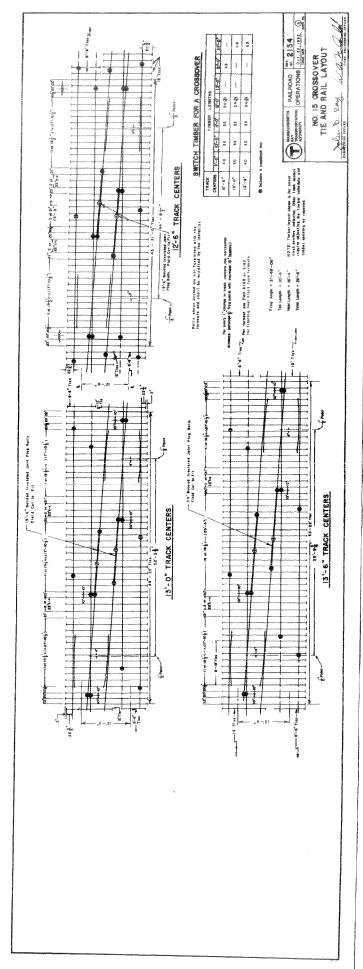
OFFSETS FOR NO. 15 TURNOUT 115 OR 132 RE RAIL-UNDEROUT

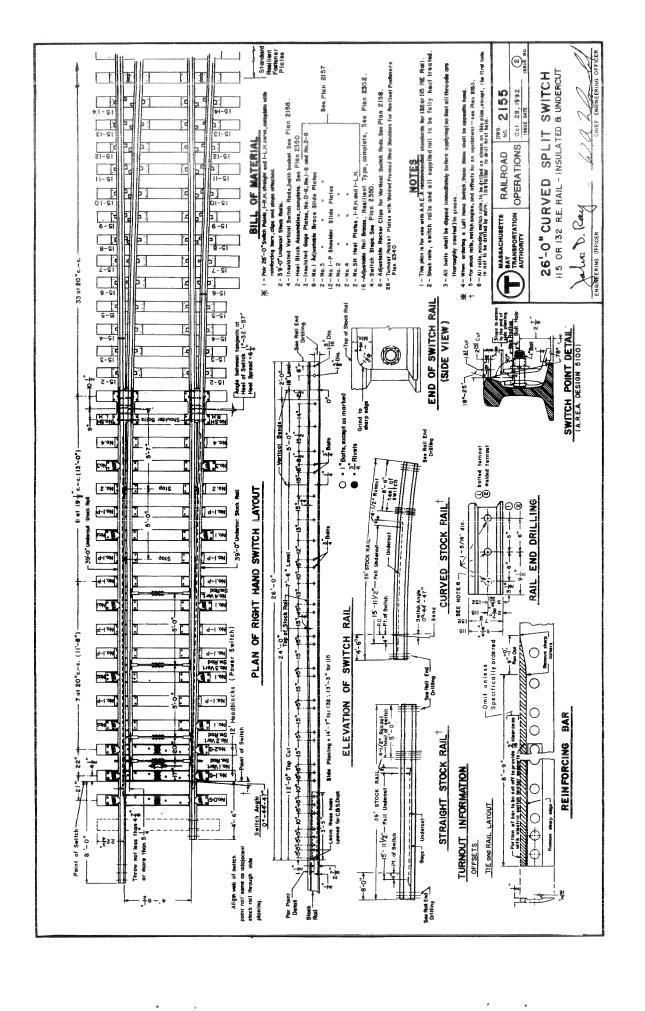
San B. Ray

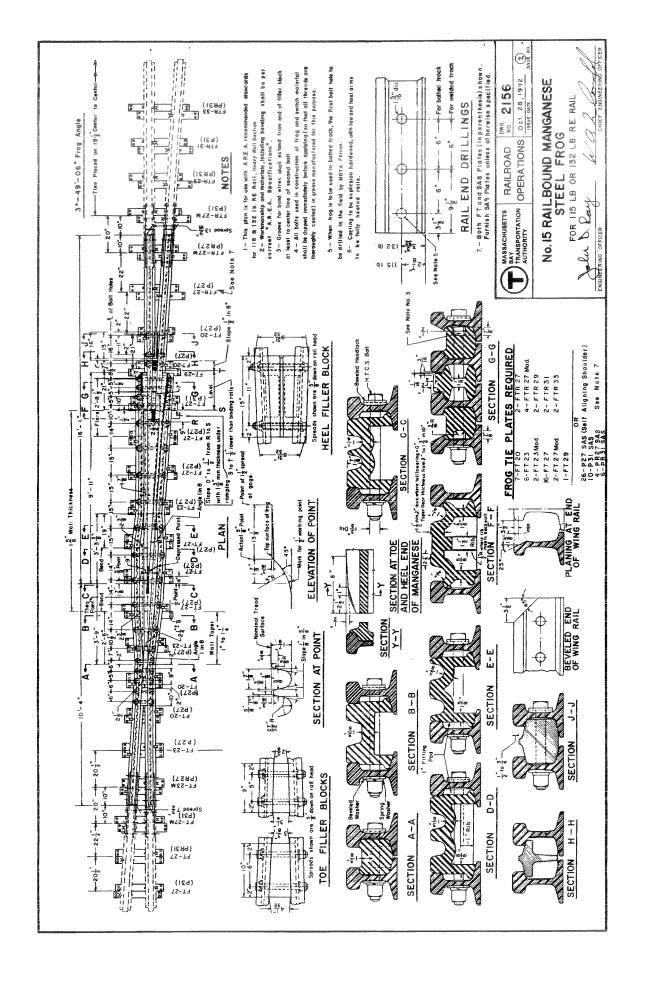


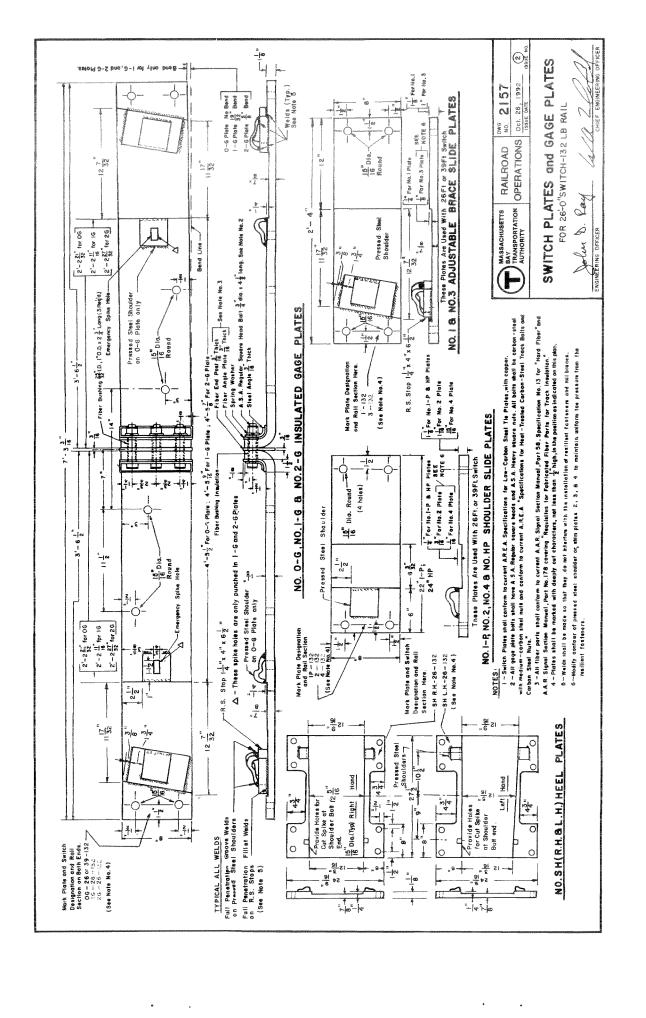


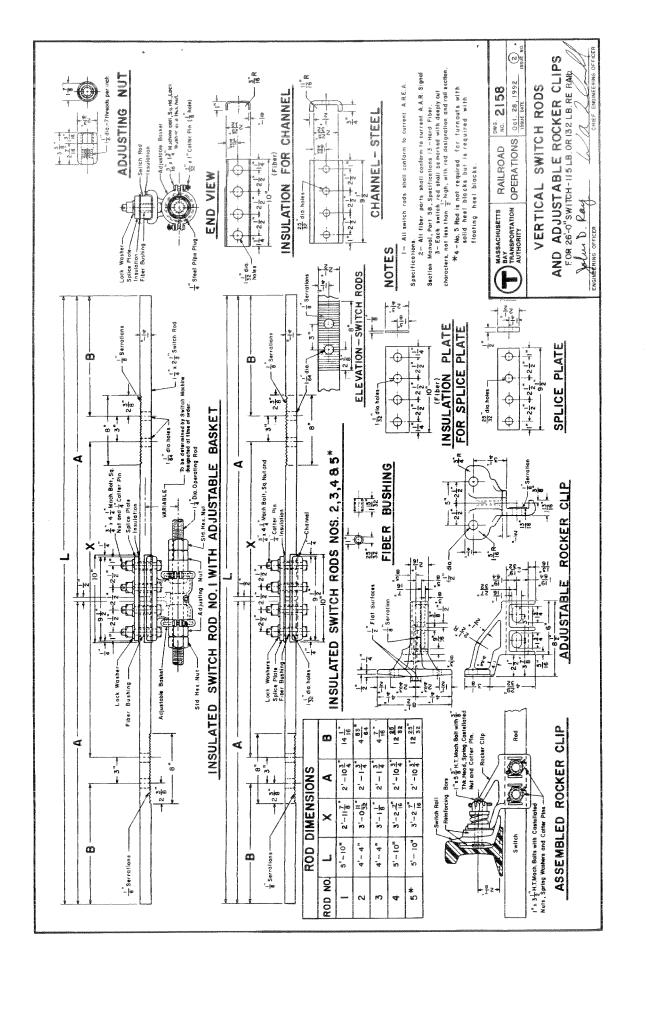
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NO. 15 TURNOUT WITH FLOATING HEEL BLOCKS BILL OF MATERIAL

, t	NO FOLOGORA	AL LACE
QUANIT		PLAN NO.
*-	PAIR 38"-O" CURYED SWITCH POINTS COMPLETE WITH REINFORCING BARS. CLIPS AND STOPS ATTACHED.	2165
2	FLOATING HEEL BLOCKS	2350
2	80'-0" UNDERCUT STOCK RAILS	2360
\$	INSULATED GAGE PLATES (NO. OG. 16, & 26)	2157
10	NO. ! ADJUSTABLE BRACE SLIDE PLATES	2157
16	NO. IP SHOULDER SLIDES PLATES	2157
7	NO. HP HEEL PLATES	2157
*	SWITCH RAIL STOPS	2350
0]	AD, 11-06 FABLE ROCKER CLIPS FOR VERTICAL SWITCH RODS	2158
×	INSULATED VERTICAL SWITCH RODS (NO. 1, 2, 3, 4 & 5))	2158
20**	TURNOUT PLATES FOR USE BEHIND HEEL OF SWITCH (NO. 15-2 R/L TO 15-8 R/L & 15-9 TO 15-151x2	2343
16	RESILIENTLY FASTENED ADJUSTABLE RAIL BRACE	2352
	NO. 15 RAILBOUND MANGAMESE STEEL FROG. COMPLETE	2156
92	NO. P27 SELF ALIGNING SHOULDER TIE PLATE	2328
10	NO. P3: SELF ALIGNING SHOULDER TIE PLATE	2328
¥	NO. PR27 SELF ALIGNING SHOULDER TIE PLATE	2328
න	NO. PR3! SELF ALIGNING SHOULDER TIE PLATE	2328
2	15'-3" MANGANESE STEEL ONE PIECE GUARD RAILS	2302
2	19'-6" BONDED INSULATED JOINT PLUG RAIL	1340
2	78'-0" LENGTHS OF FULLY HEAT TREATED RAIL	ŧ
1 0		-
; £A. +	VARIOUS LENGTHS OF FULLY HEAT TREATED RAIL AS FOLLOWS: 62'-10%", 22'-94", 20'-8"	ŧ
1202	4" SCREW SPIKES	1218
62ки	H" x 6" TRACK DRIVE SPIKES	1217
909	RESILIENT FASTENER SPRING CLIPS - TYPE "E"	ŧ
85	RESILIENT FASTENER SPRING CLIPS - TYPE MODIFIED "E"	,
218	RESILIEMT FASTENER TIE PLATES FOR SCREW SPIKES	1225
61	STANDARD JOINT BAR ASSEMBLIES	1322
7.6	STANDARD TRACK BOLTS WITH NUTS & WASHERS	1332

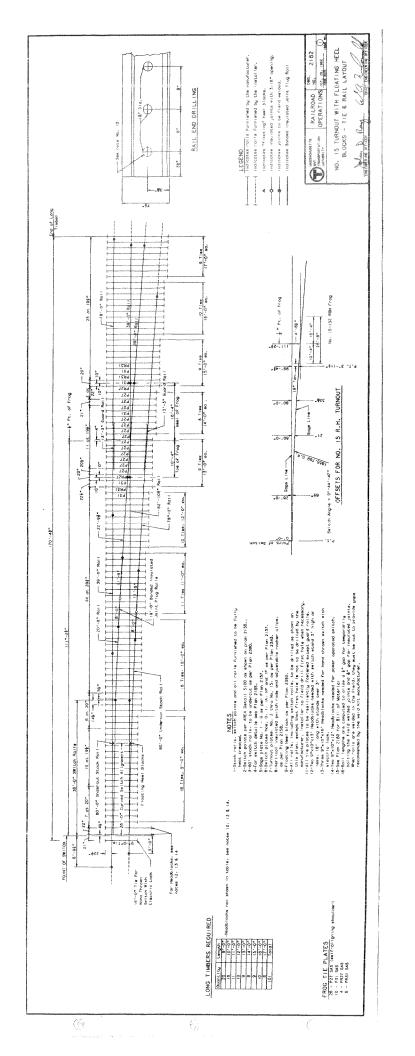
MITESE ITEMS SHALL BE SUPPLIED FOR R.H., L.H. OR EQUILATERAL TURNOUT, AS REQUIRED +FOR EQUILATERAL TURNOUTS, CLOSURE RAILS HAVE SLIGHTLY DIFFERENT LENGTHS MASUPPLIED BY THE INSTALLER

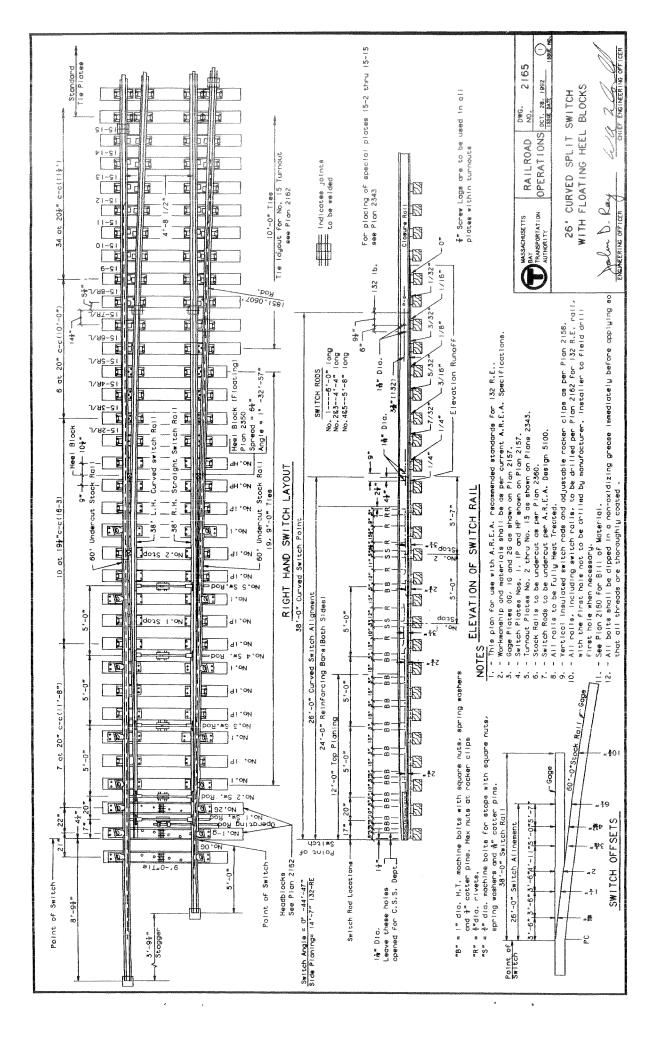
MASSACHUSETTS
BAY
TRANSPORTATION
AUTHORITY

| RAILROAD | DWG. 2160 | OPERATIONS | OPERAT

NO. 15 FLOATING HEEL BLOCK TURNOUT BILL OF MATERIAL

ENGINEERING OFFICER





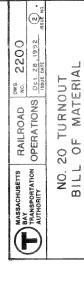
FOR A NO. 20 TURNOUT BILL OF MATERIAL

* These items shall be supplied for R.H., L.H. or Equilateral Turnout as required.

Quantity	Description	Reference Plan No.
-	FTR33 Modified Hook Twin Tie Plates	2326
2	13'-3" Manganese Steel One Piece Guard Rails	2302
į	Bonded Insulated Joint Assembly	VANDALIA .
2	39'-0" Bonded insulated Joint Plug Raff	1340
12	39'-0" Langths of Fully Haat Treated Rail	Same .
lea. †	Various Lengths of Fully Heat Tregled Rail as follows:	****
0161	7" Lock Spikes	12.18
140	S. A. A. R. A. S. B. K. 8. 8. 8. 8.	1210
935	Resilient Fostener Spring Clips Type "E.	***************************************
15	Resilient Fastener Spring Clipe-Type Modified "E"	and the state of t
380	Standard Resilient Fastener Tie Piotes	1224
2	Pairs of Modified Joint Bar Assembles (Head & Toe of Gage Side Bars Removed to Allaw Switch Movement at Joint near Heel of Switch - No.20.0aly)	2202
	Mechanism for Bell Crank Heiper, Complete	2209
22	Standard Joint Bar Assemblies	1322 or 1320
88	Standard Track Boits with Nuts and Washers	332
Contraction Charles and Contraction Contra	THE PROPERTY OF THE PROPERTY O	On Copy of the State of Comments of Commen

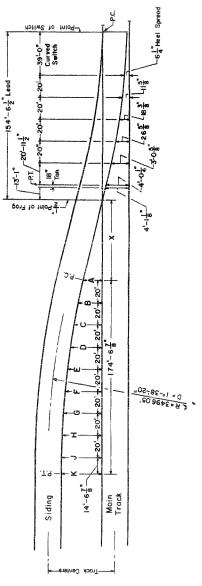
- ** Cut spikes are to be furnished by the installer.
 Weld Kits (2.4) to be furnished by the installer.

 † For Equilateral Turnout, closure rails have slightly different lengths. See Equilateral Drawing (2203).
- NOTES: I.Turnouts supplied shall be sither 115 or 132 L.B. R.E. as specified in the order.
 - 2. Turnouts shall be resiliently fastened throughout, except Freg Tie Plates, Guard Ralls and locations where Spring Clips cannot be physicaly installed such as on turnout plates near heel.
- 3. Fabricator shall supply all material required for the complete institution of the turnout except switch timber unless otherwise specified in the order.
 - 4. For Switch Timber Schedula, see Pion 2202.



LA CHEF ENGINEE

John D. Rang ENGHMEERING OFFICER



OFFSETS BEHIND THE HEEL OF FROG

F-100-00-00-00-00-00-00-00-00-00-00-00-00	-	_							
×	7-52	7'-71"	794	1	8'-12"	. 3 ^L "	8'-52"	8'-72"	9'-9-
2	7-5\$	7*-7 1	7'-9"	7'-11	8,-14,	8,-3 L "	- 1 8,8	8'-7-'8	# 6-,8
I	7'-32"	7'-5-"	7'-7"	7'-92"	7'-112"	8'-12"	8-32"	9,-2,4	
Ø	7-03	7'-23"	7'-43"	763.	7'-83"	7'-103"	8,-03	8'23"	8 -4 3
L	6,8	"OI,9	1,0-,2	7.2"	7'-4"	.9-,2	78"	1-10 m	,0 -, e
Ш	6'-2 	6,-4-8	e s	6 - 8 - 8	# 0!, 9	# 0-,1	7'-28"	7-4-"	768
۵	5'-7"	2,9"	5'-!!"		8'-3"	6'-5"	6'-7"	#6-,9	!!-,9
၁	4'10 3"		5 - 2 3 "	5'-43"	5'-63"	5 8 3 "	5'-10 3 "		6 - 2 3 =
8	4'- 01	4'-2-"	4-4-4	4'-6"	4'-84"	4'-10-2"	5,-0-1		5 -4-
A	3'-1="	3'-3-"	3'-5 1"	3'-7\frac{1}{8}"	3'-9-"	3'-!! - '8	4'- 18"	4-3-1	4'-5 "
×	<u>" ₹0-,19</u>	64'-4 "	67'-8 <u> </u> "	11,-04"	74' 4 "	1,8-,22	80'-117"	84'-37"	87'-8"
TRACK CENTERS	12'-2"	12'-4 "	12- 6 "	12-8 "	12'-10"	13'-0"	13-2	13'- 4 "	13-6"

Values for track centers not shown may be determined by interpolation.

TURNOUT DATA FOR BOLTED TRACK

FROG-R.B.M.

NOTES

- I The lines of the diagram indicate gage lines.
 - 2- For details see the following plans:--Switch- 2205 or 2215

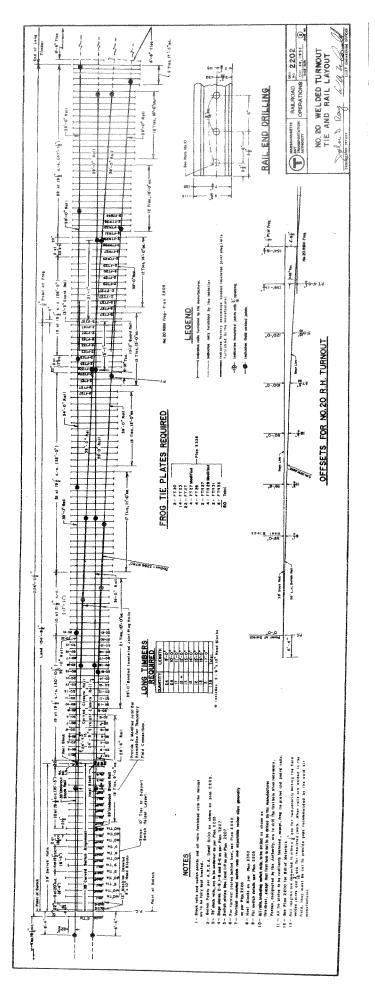
Frog-R.B.M. 2206

3- For welded turnouts see Plan 2202 or 2212 for offsets between the point of switch and the toe of frag.

MASSACHUSETTS RAILROAD NO. 2201
TRANSPORTATION OPERATIONS OCI. 1890E DATE

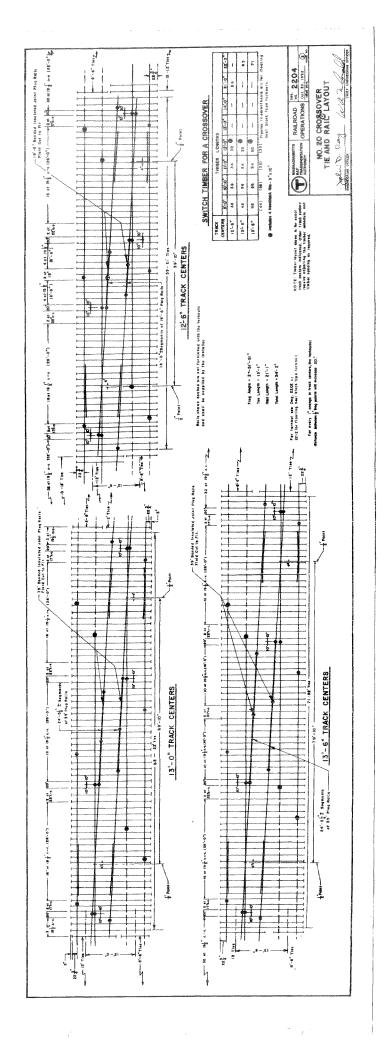
OF FSETS FOR NO. 20 TURNOUT IIS OR 132 R.E. RAIL - UNDERCUT

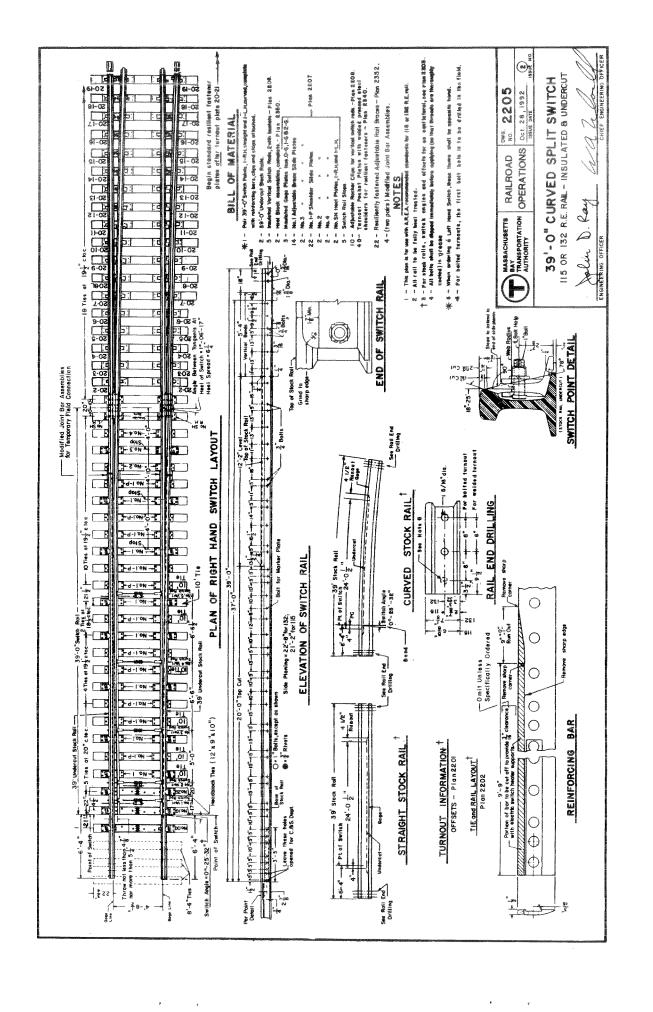
John D. Ray

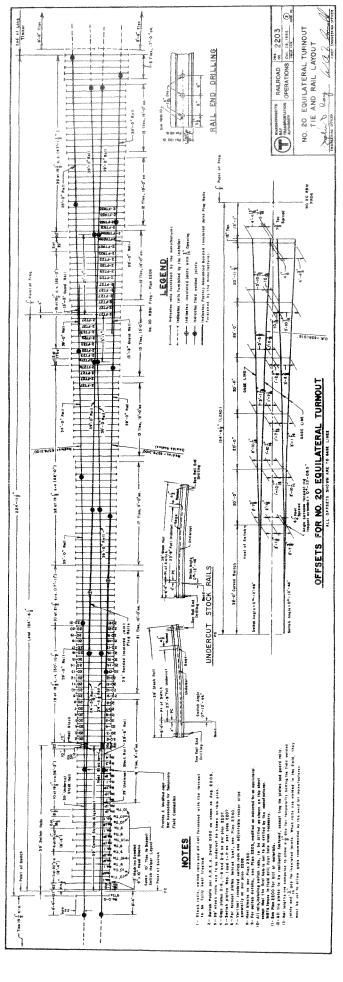


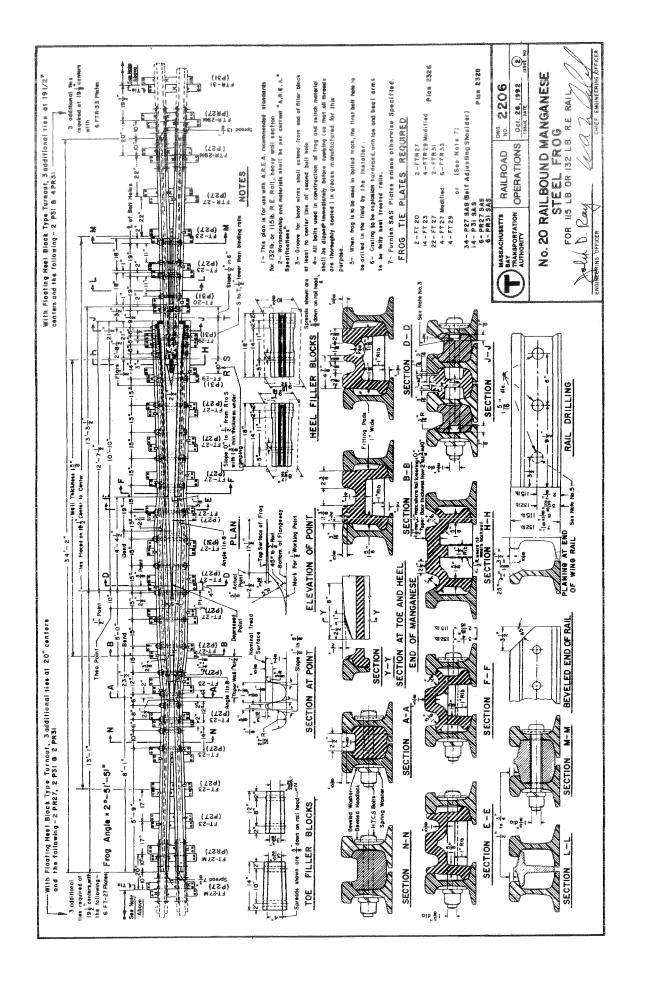
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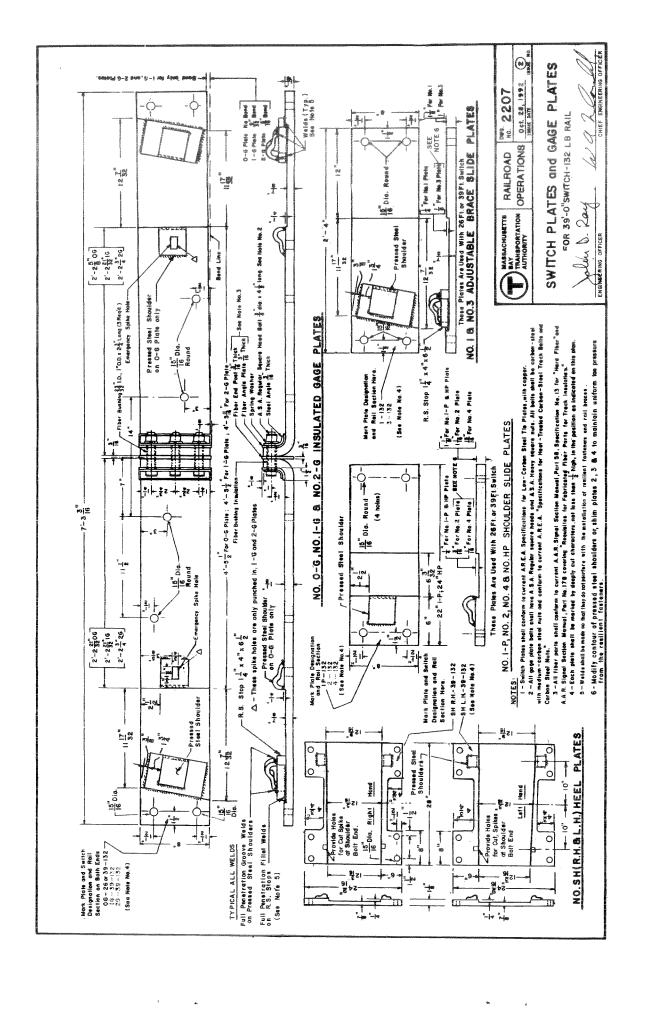
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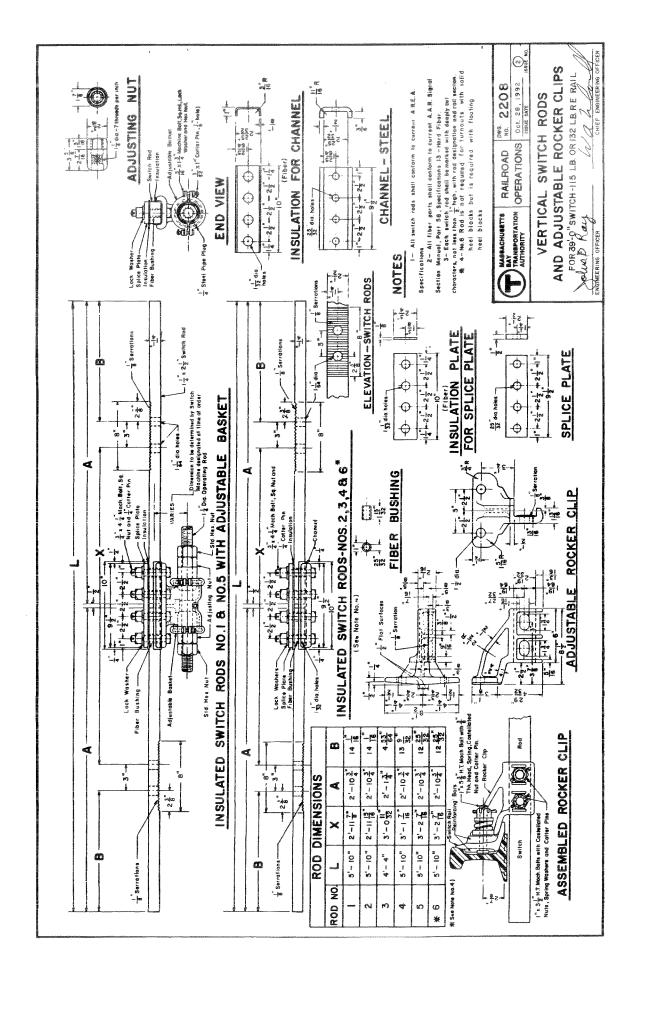


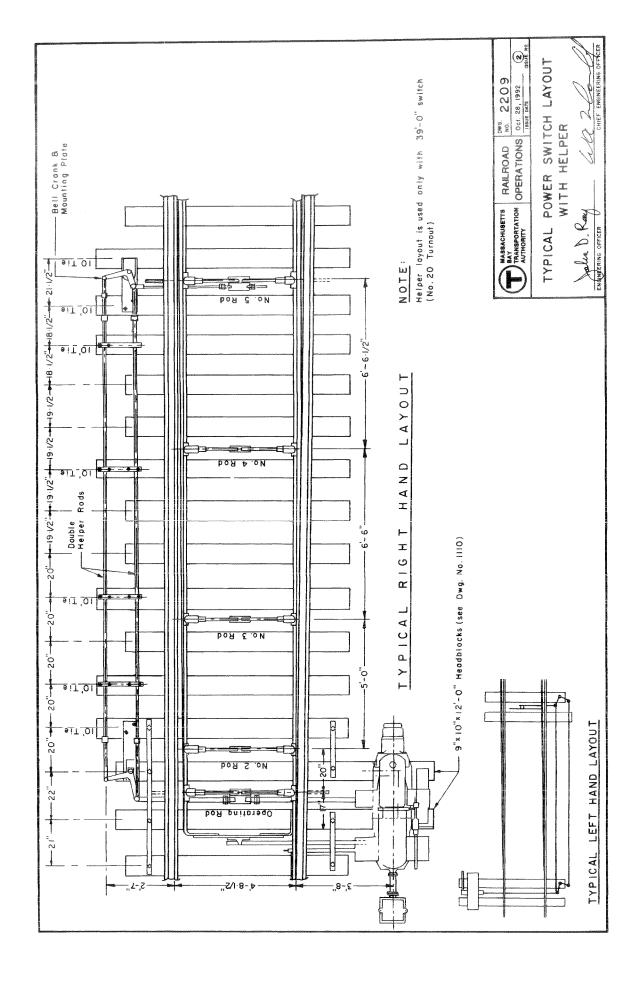












NO. 20 TURNOUT WITH FLOATING HEEL BLOCKS BILL OF MATERIAL

DESCRIPTION	PLAN NO.
PAIR 39'-6" CURVED SWITCH PUINTS COMPLETE WITH REINFORCING BARS, CLIPS AND STOPS ATTACHED.	2215
FLOATING HEEL BLOCKS	2350
60'-0" UNDERCUT STOCK RAILS	2360
INSULATED GAGE PLATES (NO. 06, 16, 8 26)	2207
NO. 1 ADJUSTABLE BRACE SLIDE PLATES	2207
IP SHOULDER SLIDES PLATES	2207
HP HEEL PLATES	2207
SWITCH RAIL STOPS	2350
ADJUSTABLE ROCKER CLIPS FOR VERTICAL SWITCH RODS	2208
ED VERTICAL	2208
TURNOUT PLATES FOR USE BEHIND HEEL OF SWITCH (ND. 20-2 R/L TO 20-8 R/L 8, 20-9 TO 20-21)×2	2343
RESILIENTLY FASTENED ADJUSTABLE RAIL BRACE	2352
20 RAILBOUND MANGANESE STEEL FROG, COMPLETE	2206
P27 SELF ALIGNING SHOULDER TIE PLATE	2328
P3: SELF ALIGNING SHOULDER TIE PLATE	2328
PR27 SELF ALIGNING SHOULDER TIE PLATE	2328
PR31 SELF ALIGNING SHOULDER TIE PLATE	2328
13'-3" MANGAMESE STEEL ONE PIECE GUARD RAILS	2302
19"-6" BONDED INSULATED JOINT PLUG RAIL	1340
78'-0" LENGTHS OF FULLY HEAT TREATED RAIL	*
OF FULLY HEAT TREATED RAIL	ź
VARIOUS LENGTHS OF FULLY HEAT TREATED RAIL AS FOLLOWS: 42'-114", 37"-4",25"-24"	
SCREW SPIKES	1218
H" x 6" TRACK DRIVE SPIKES	1217
RESILIENT FASTENER SPRING CLIPS - TYPE "E"	ā.
RESILIENT FASTENER SPRING CLIPS - TYPE MODIFIED "E"	í
RESILIENT FASTENER TIE PLATES FOR SCREW SPIKES	1225
STANDARD JOINT BAR ASSEMBLIES	1322
STANDARD TRACK BOLTS WITH NUTS & WASHERS	1332

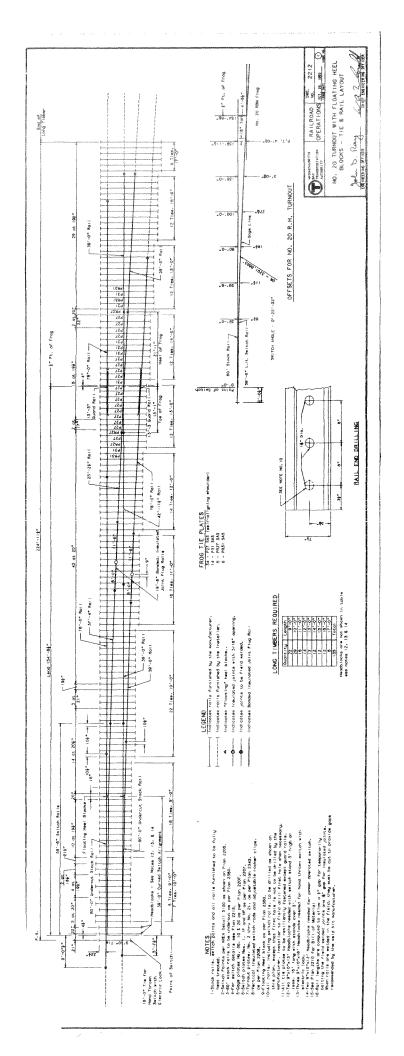
WINESE ITEMS SHALL BE SUPPLIED FOR R.H., L.H., ON EQUILATERAL TURNOUT, AS REQUIRE *FOR EQUILATERAL TURNOUTS, CLOSURE RAILS HAVE SLIBHTLY DIFFERENT LENGTHS
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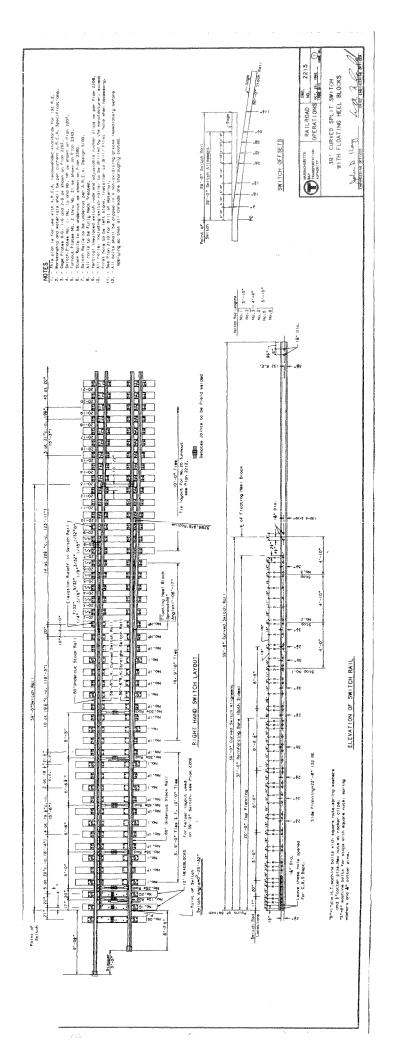
MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

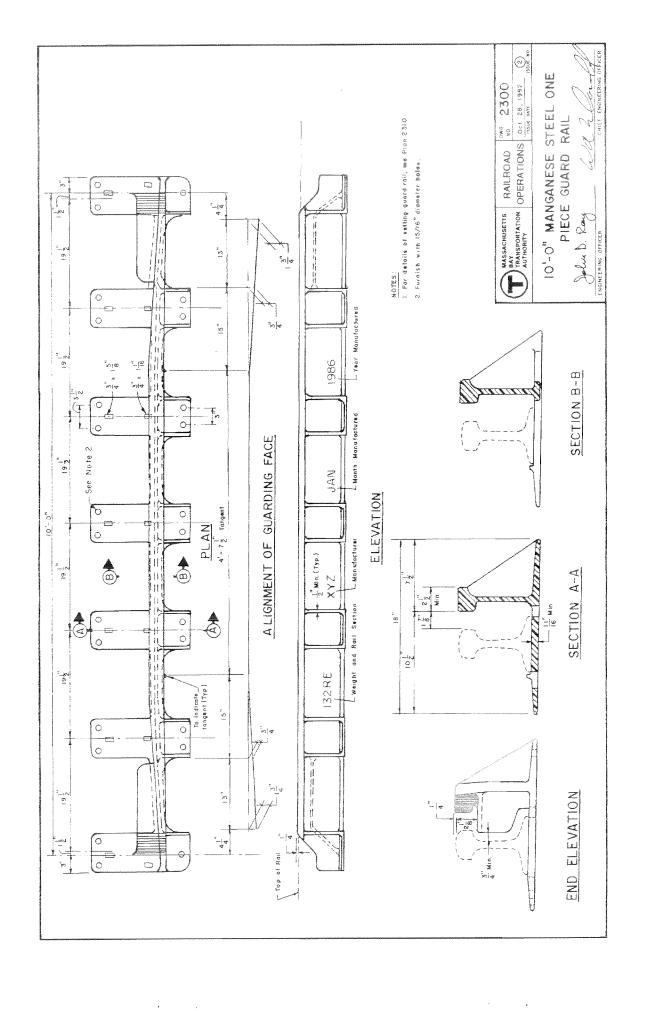
NO. 20 FLOATING HEEL BLOCK TURNOUT BILL OF MATERIAL

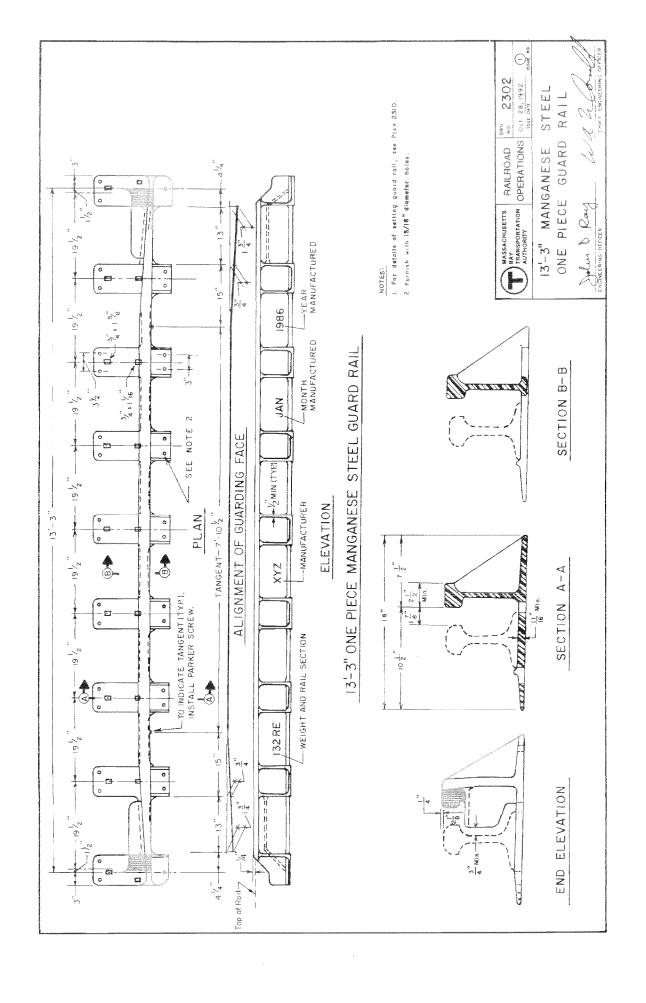
John D. Ray

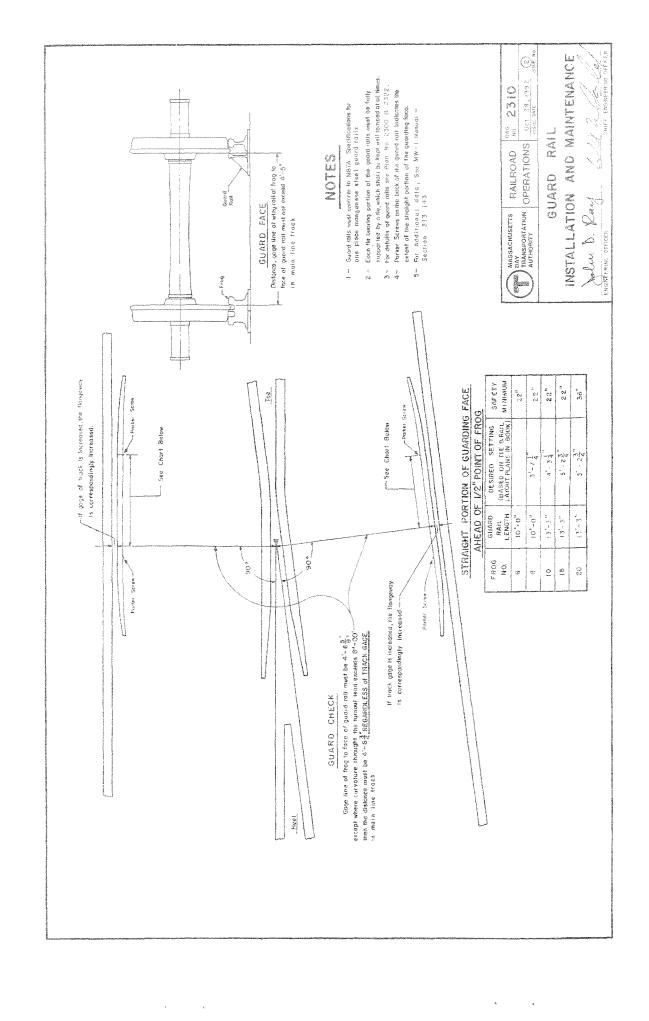
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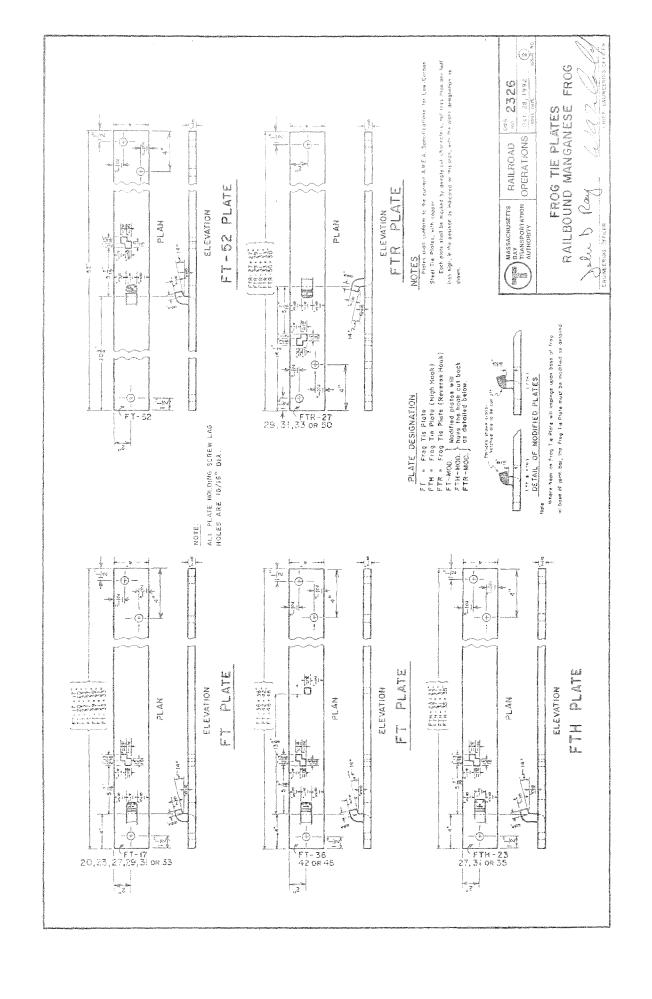


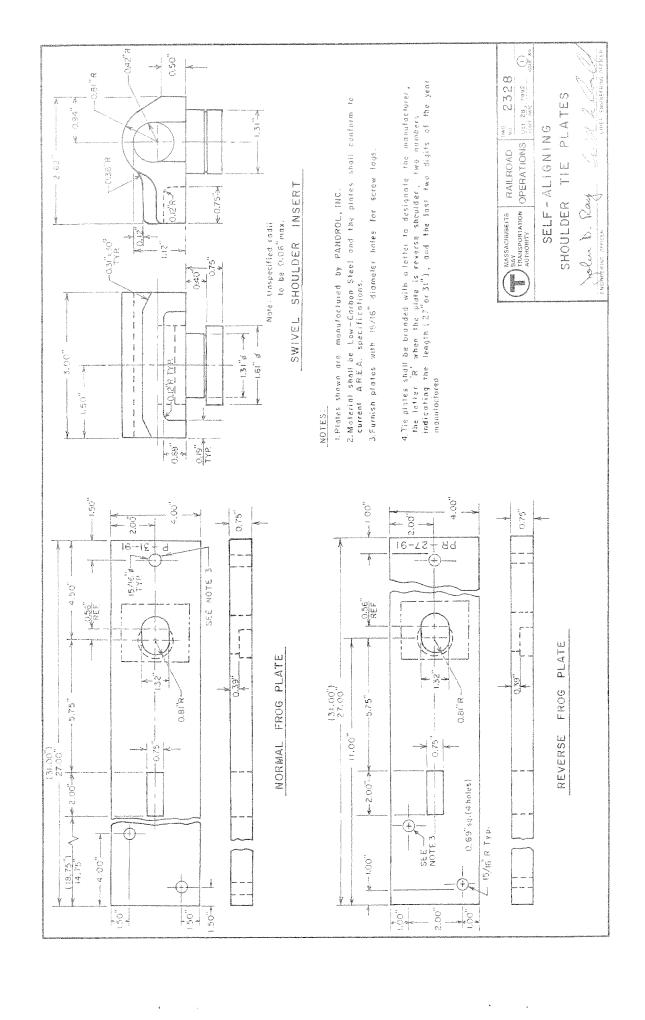


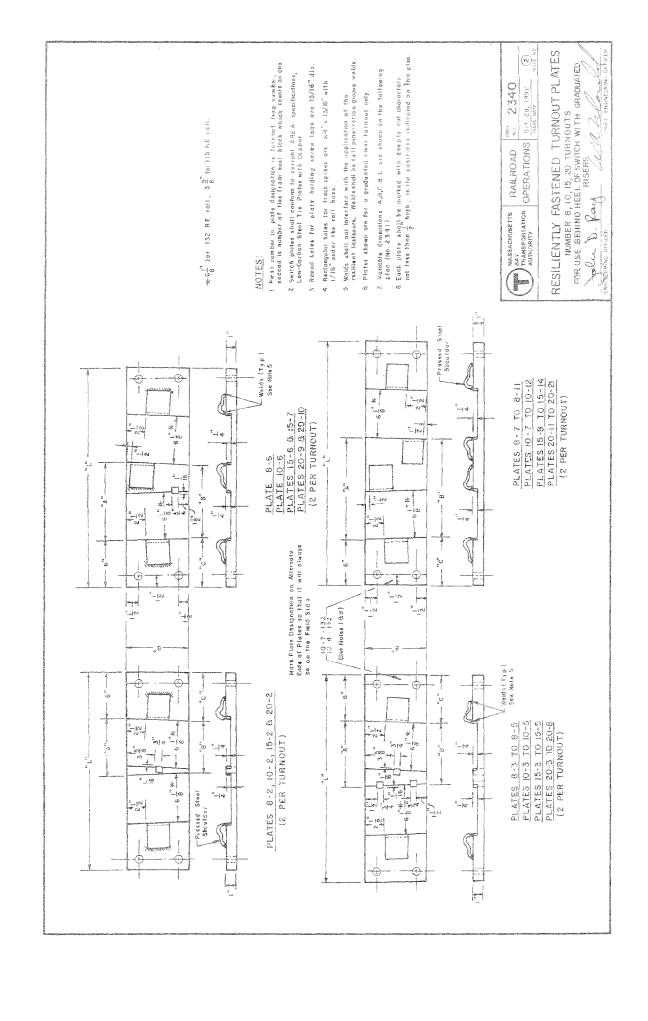












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	MASSACHUSETTS	BAY	TRANSPORTATION	AUTHORITY
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AILROAD NO 2341

PERATIONS OCT 29, 1992

TABLE OF DIMENSIONS FOR RESILIENTLY FASTENED TURNOUT PLATES

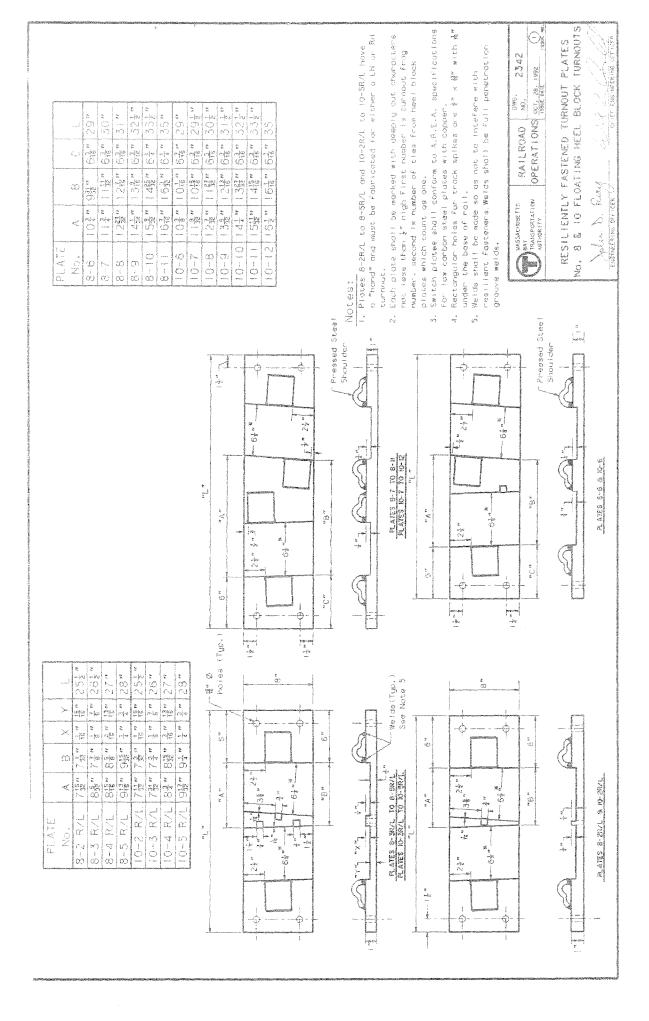
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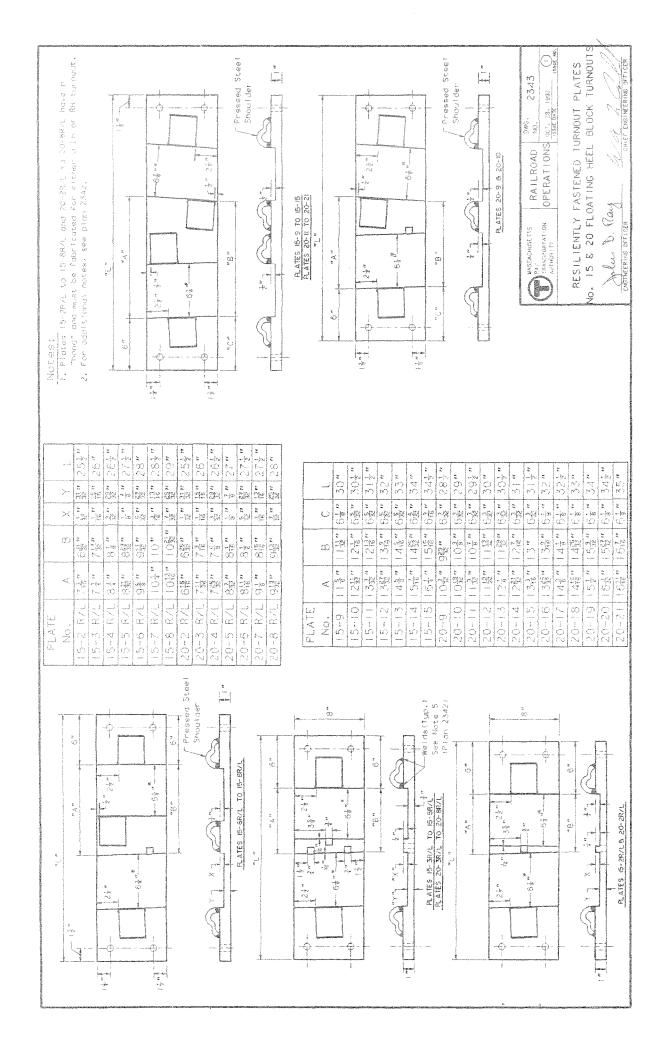
ENGINEERING OFFICER

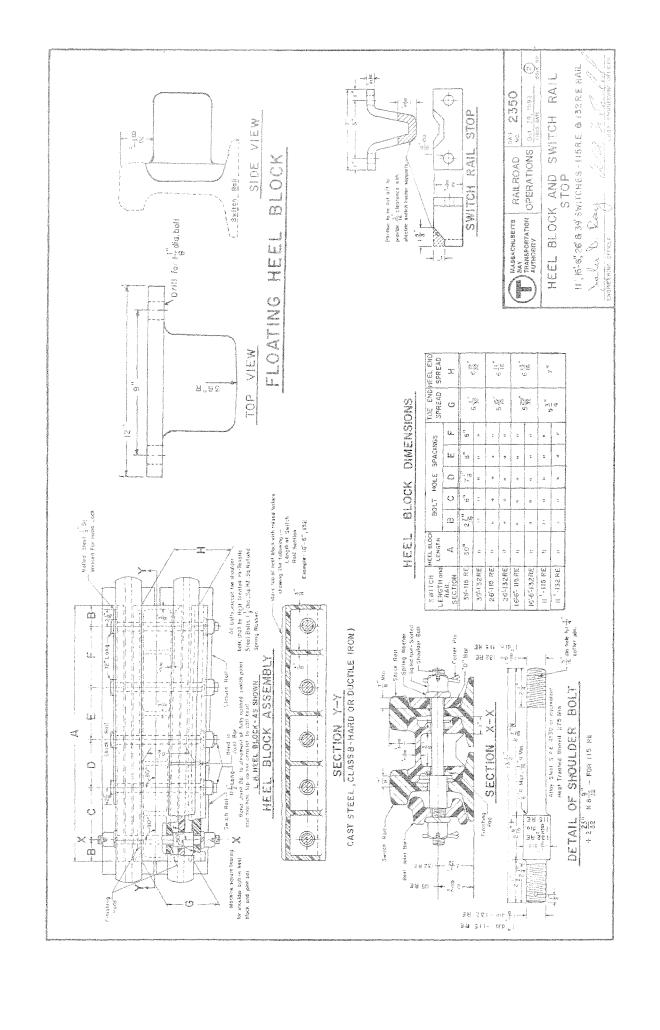
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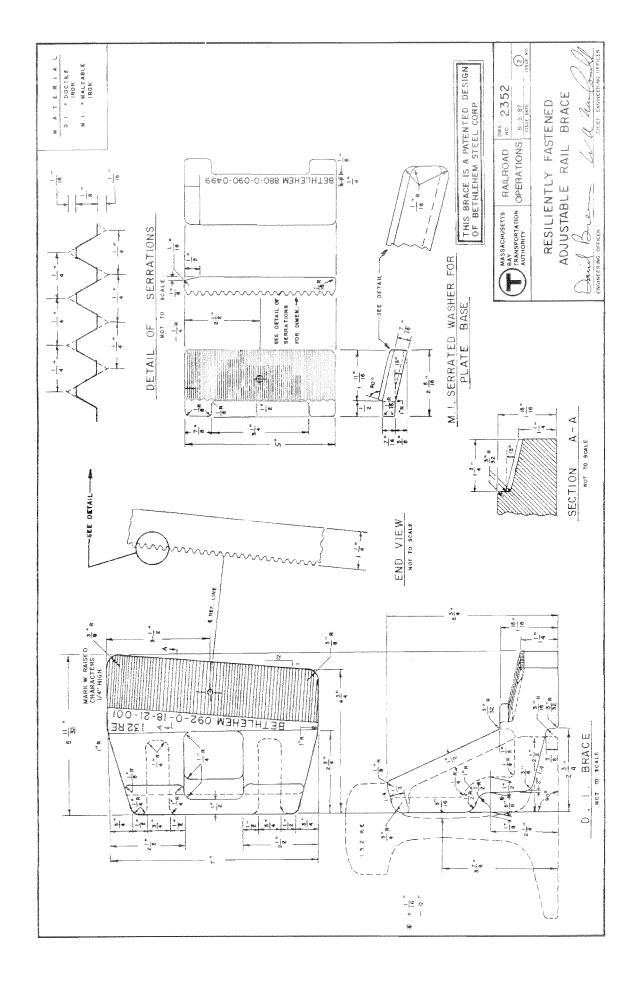
17 See previous plan (No. 2340-tHer diagram, showing the location of dimensions A,B,C,R,L

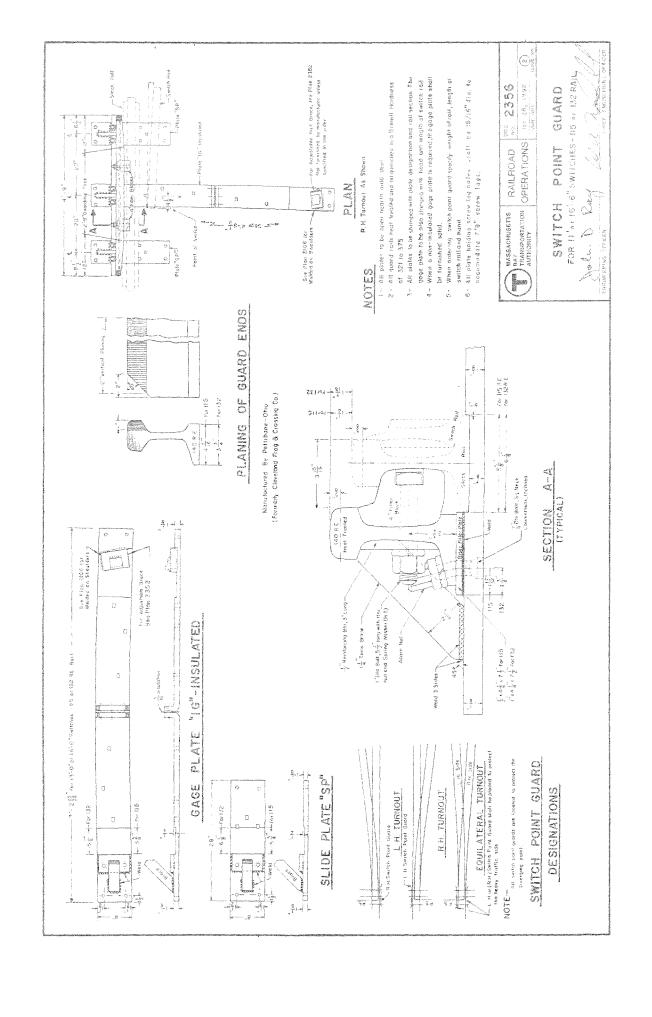
 \mathbb{R}^{∞} Dimensions shown are only for the specials shown an corresponding Tie and Roll Layout Plans.

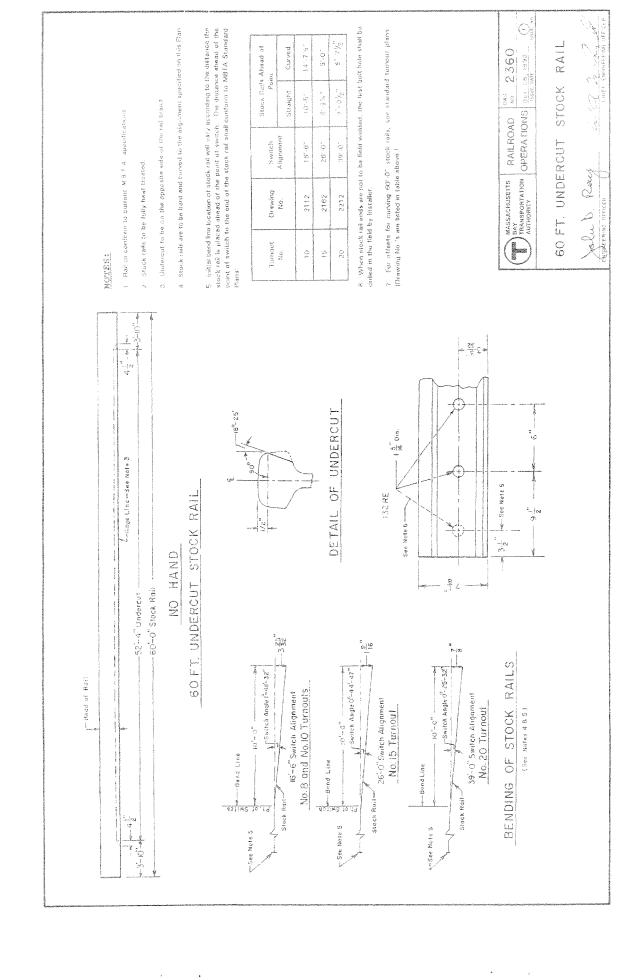


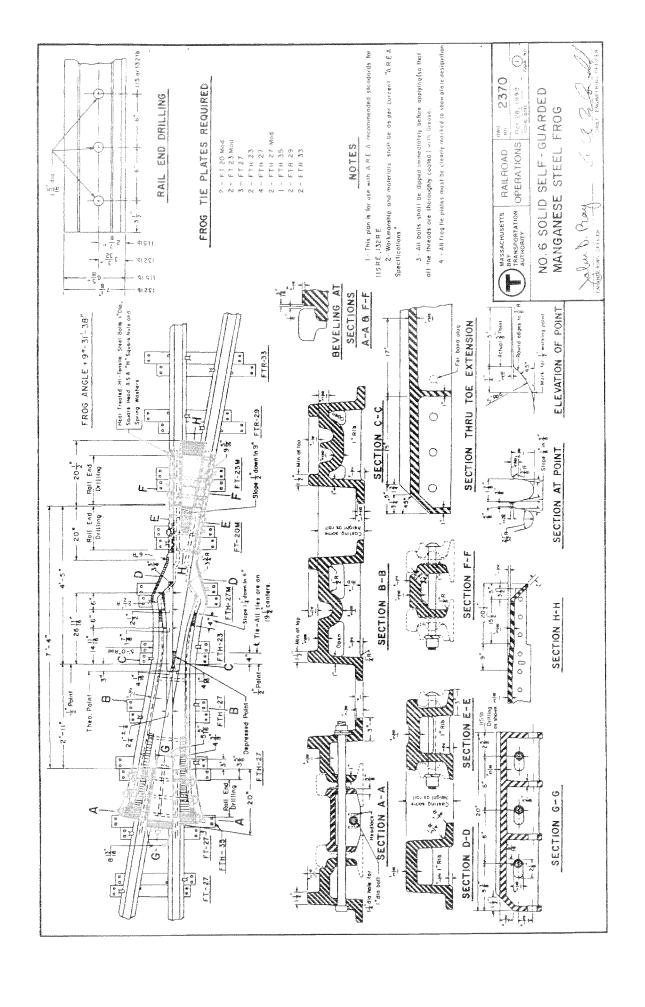


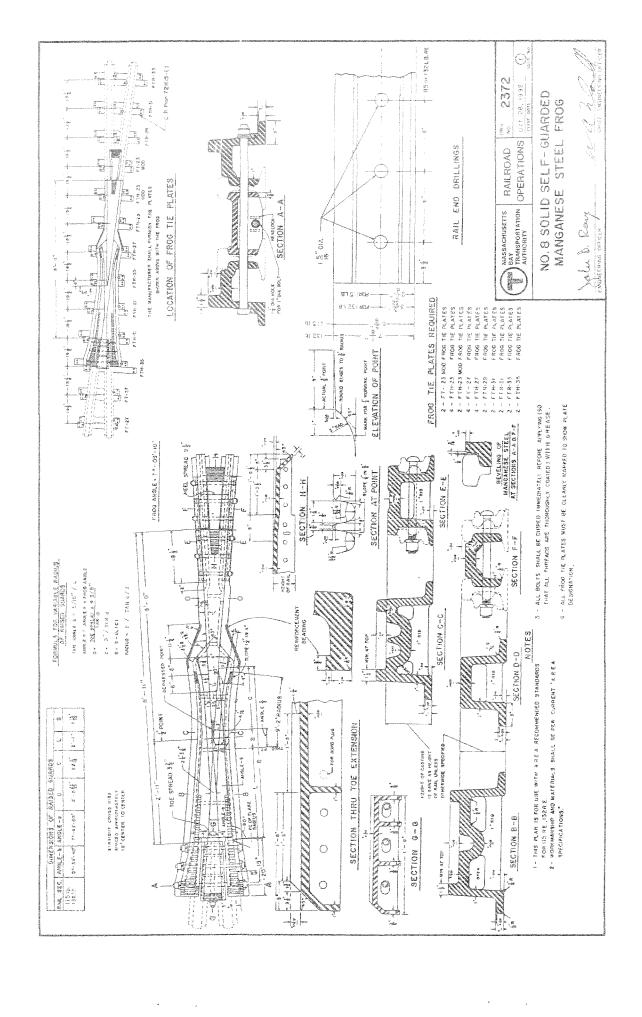


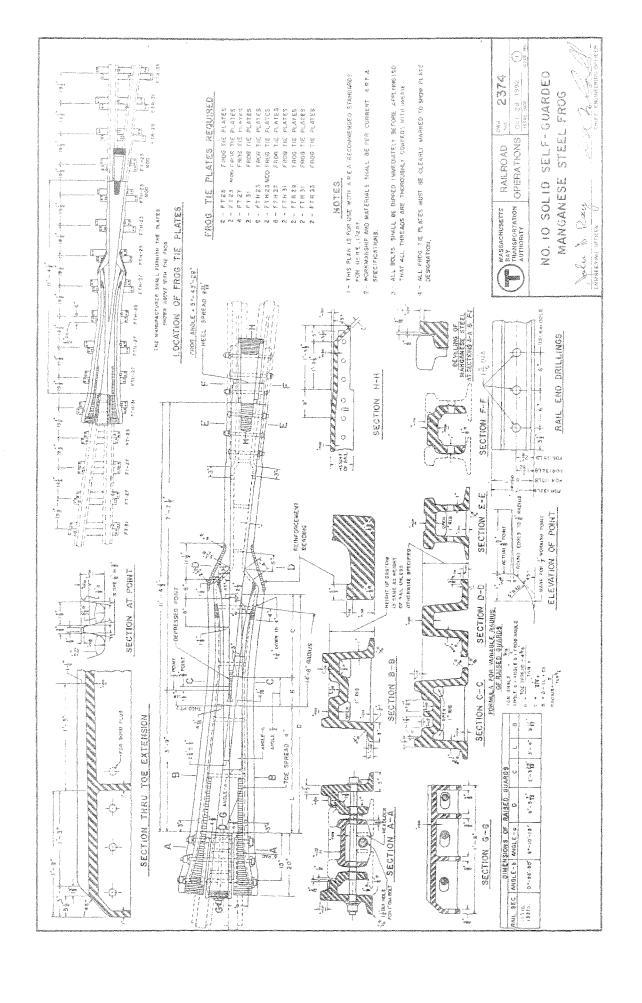


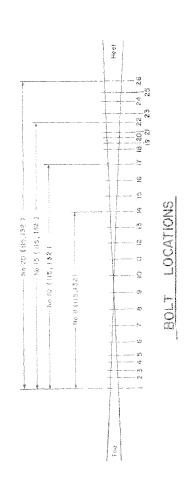






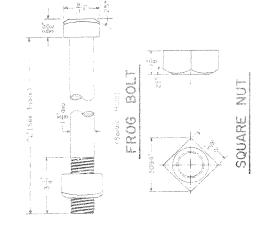






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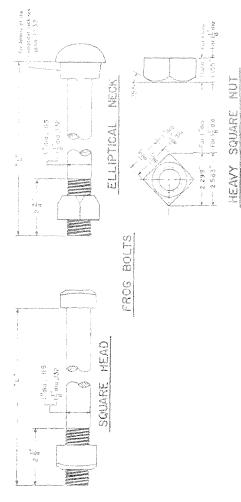
- 1. Byths, and hars shall contain to current AHP to Specifications this secural modework. Among the Byth details a physical this plant.

 Beth from that set ASA (BH) 22 (1965).

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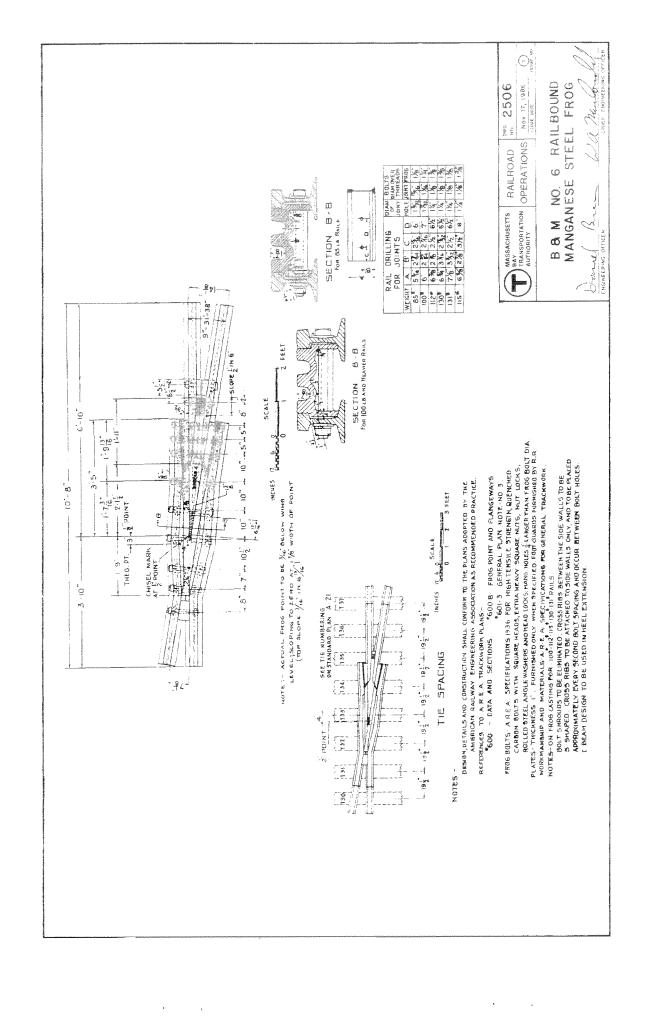
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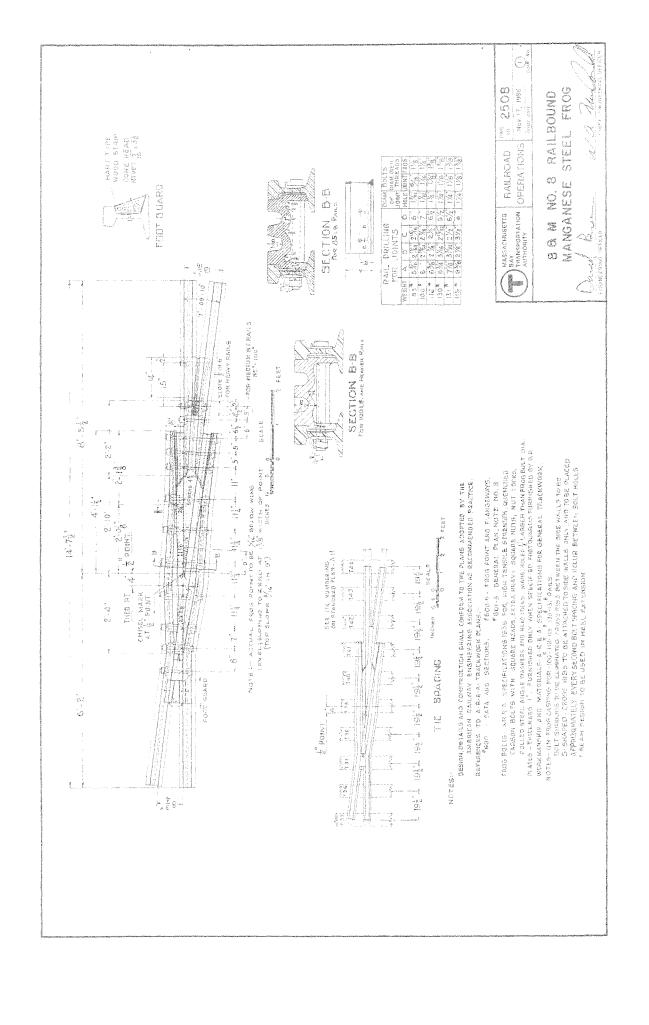
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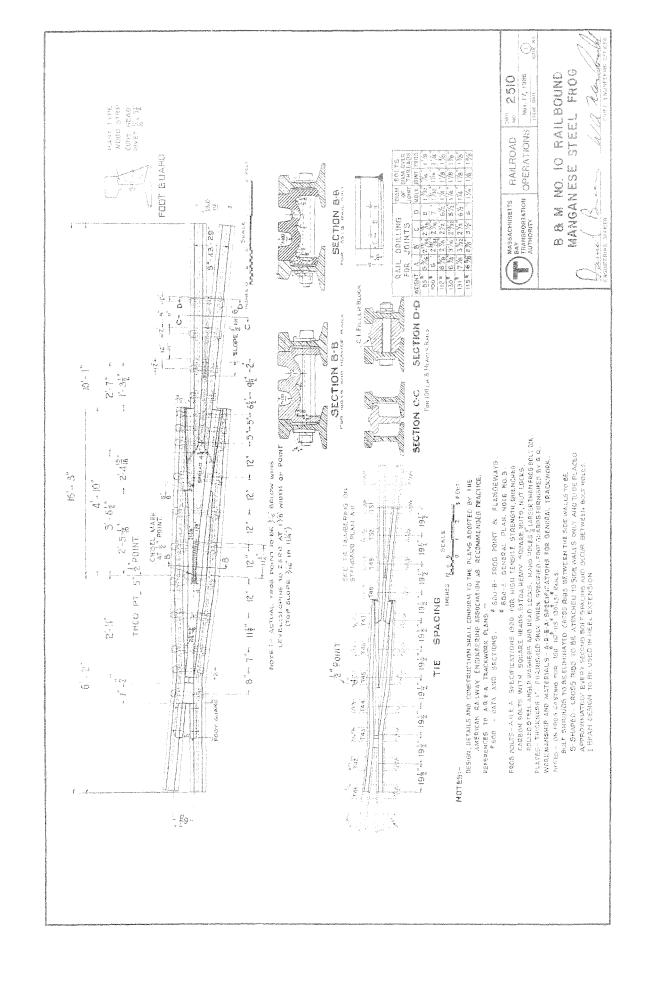
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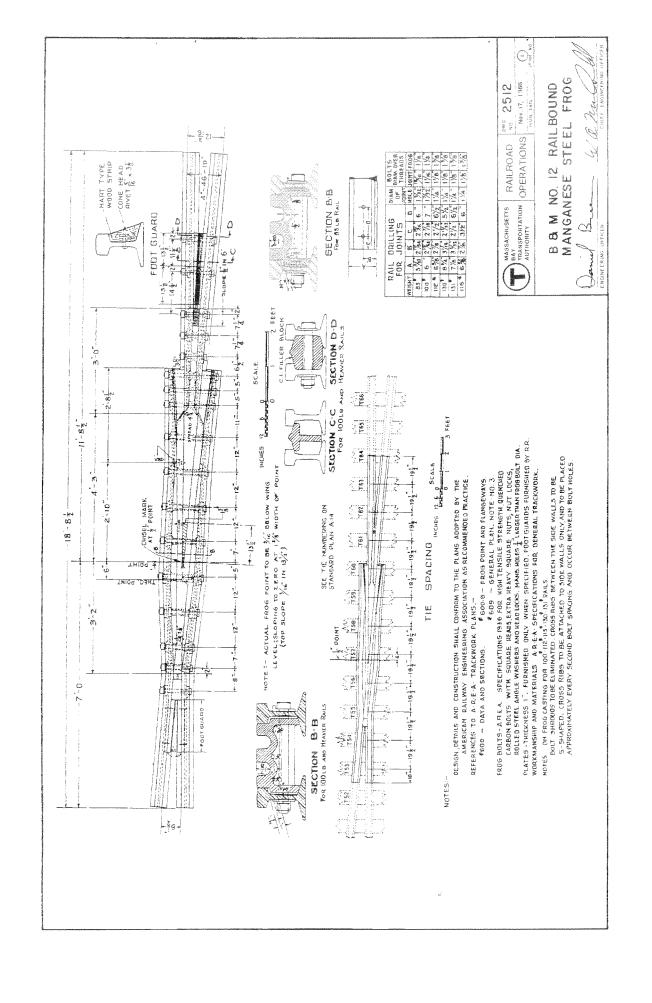
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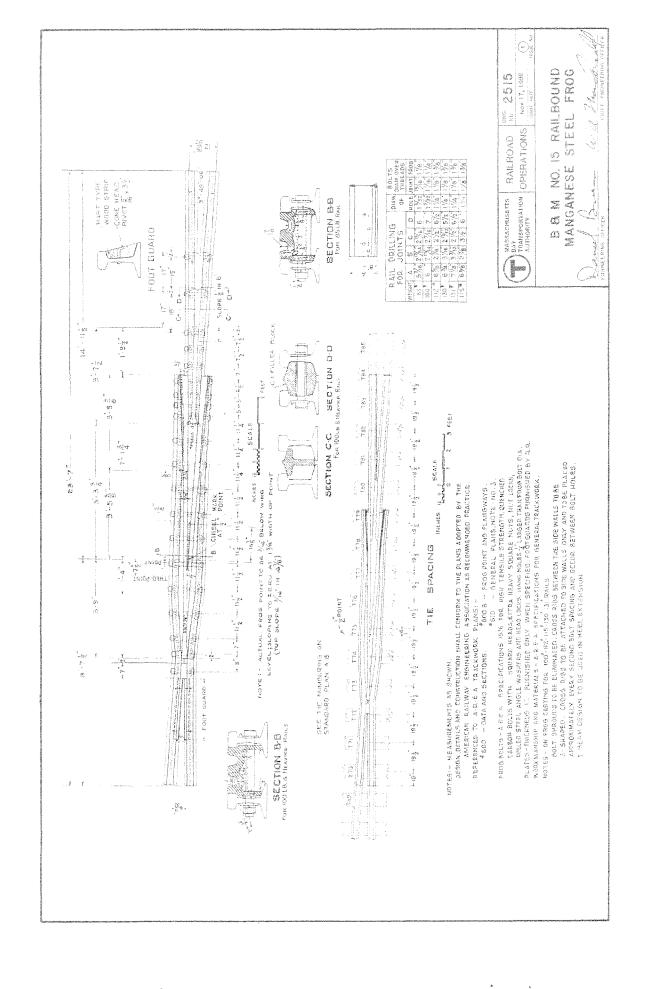
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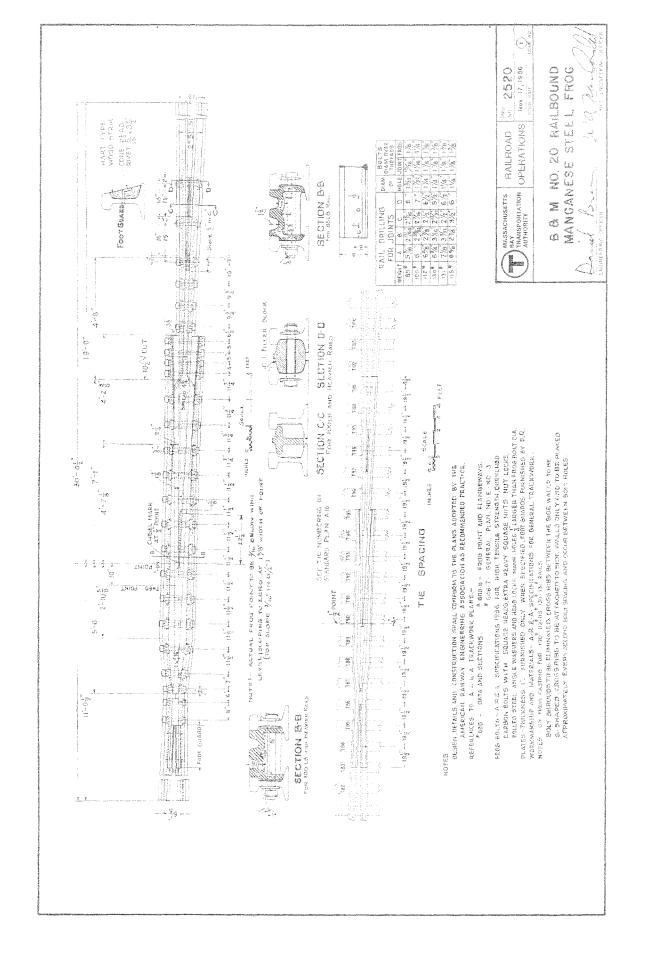


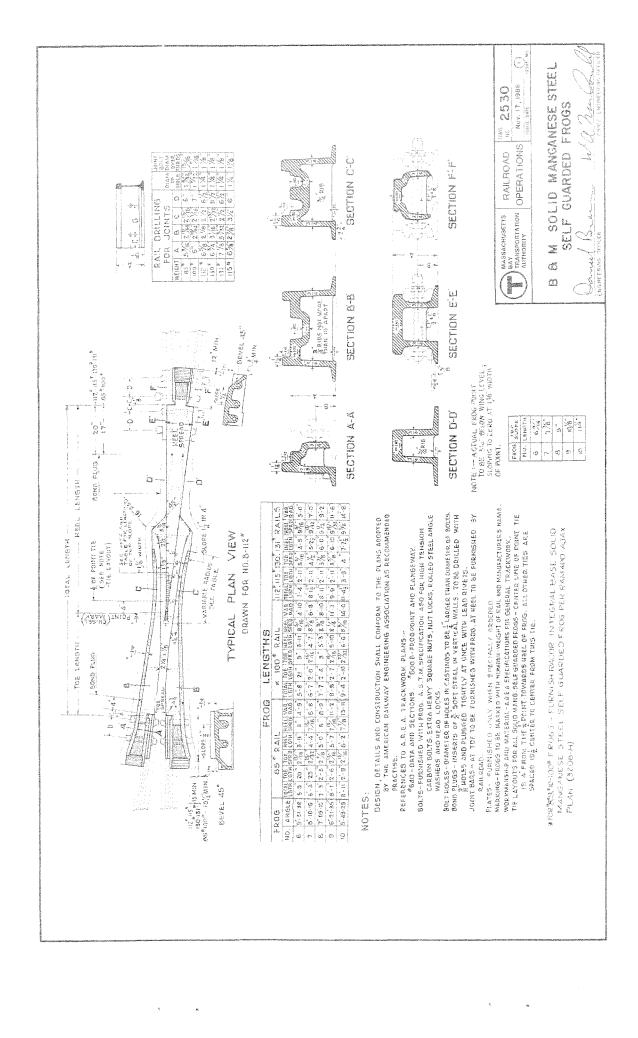


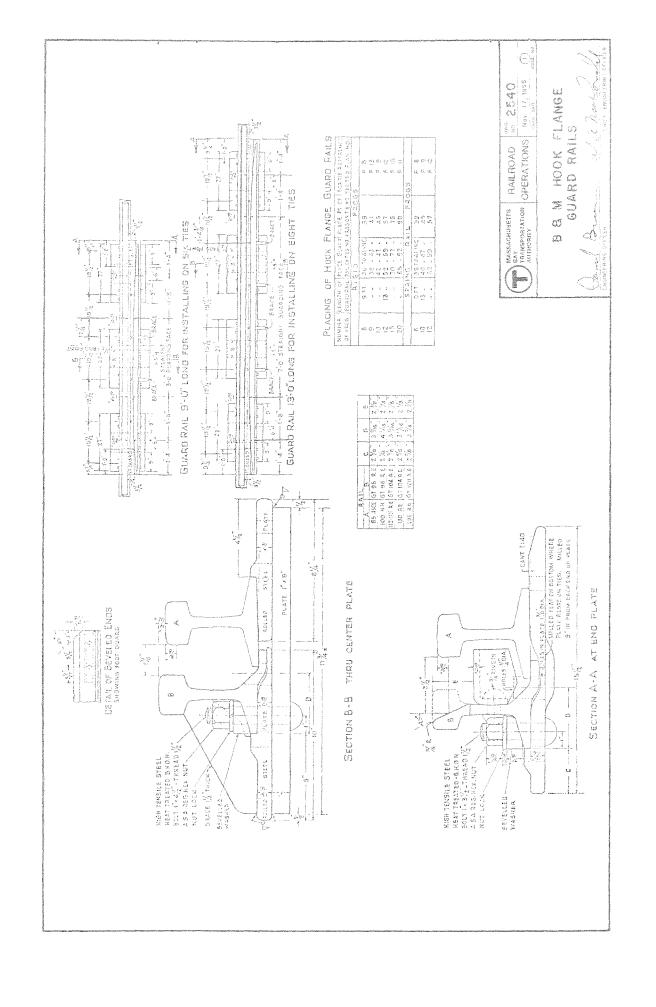


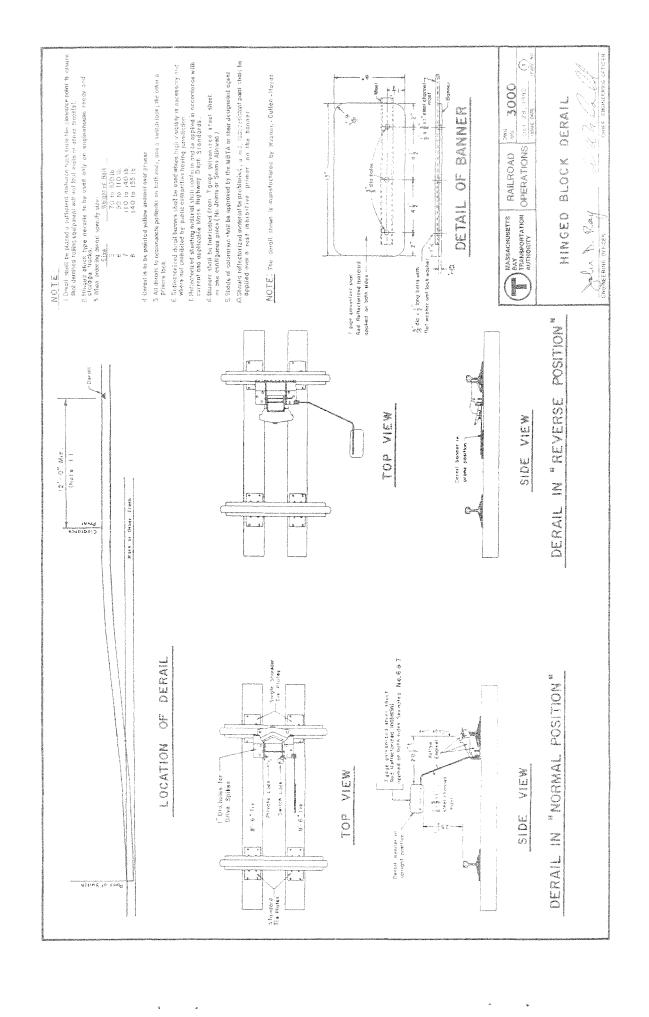


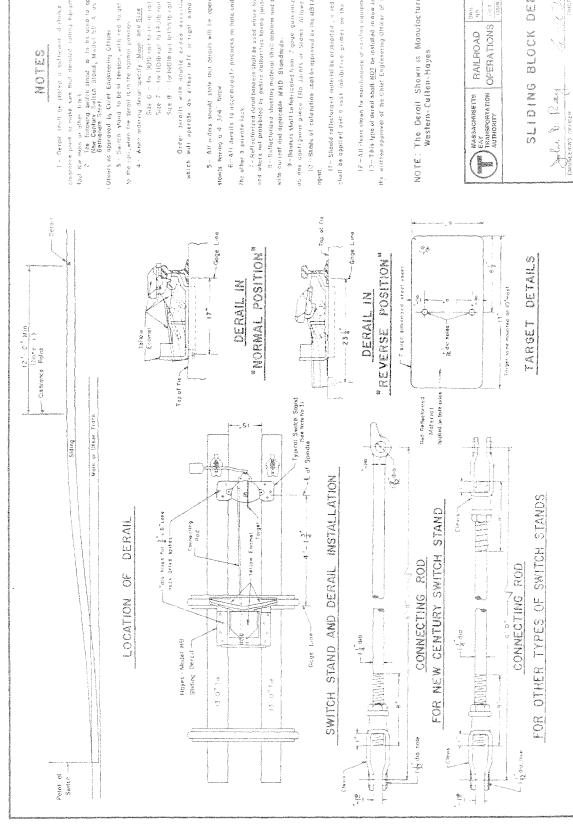












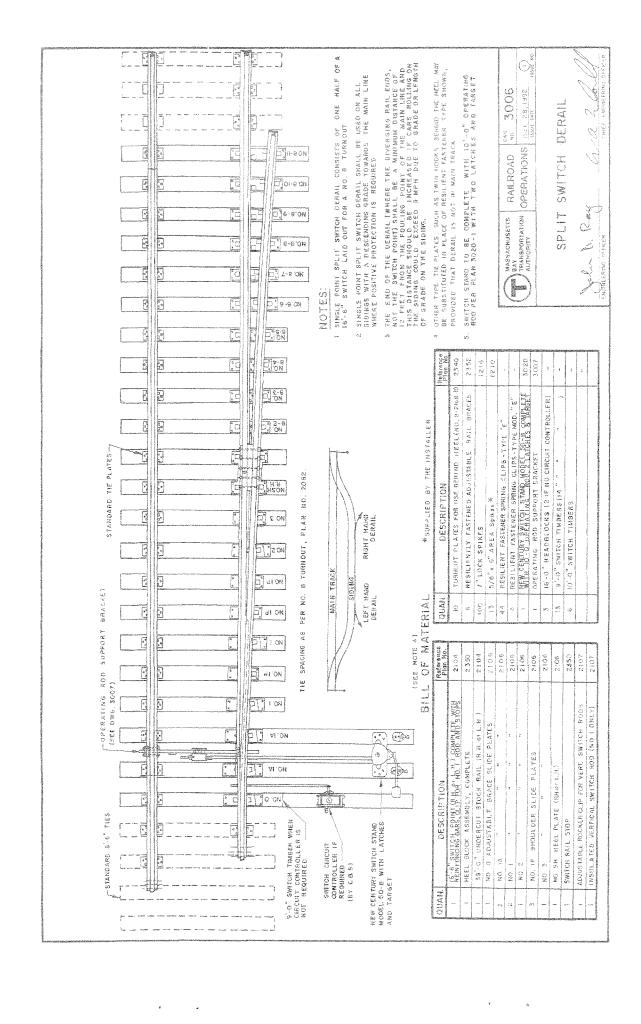
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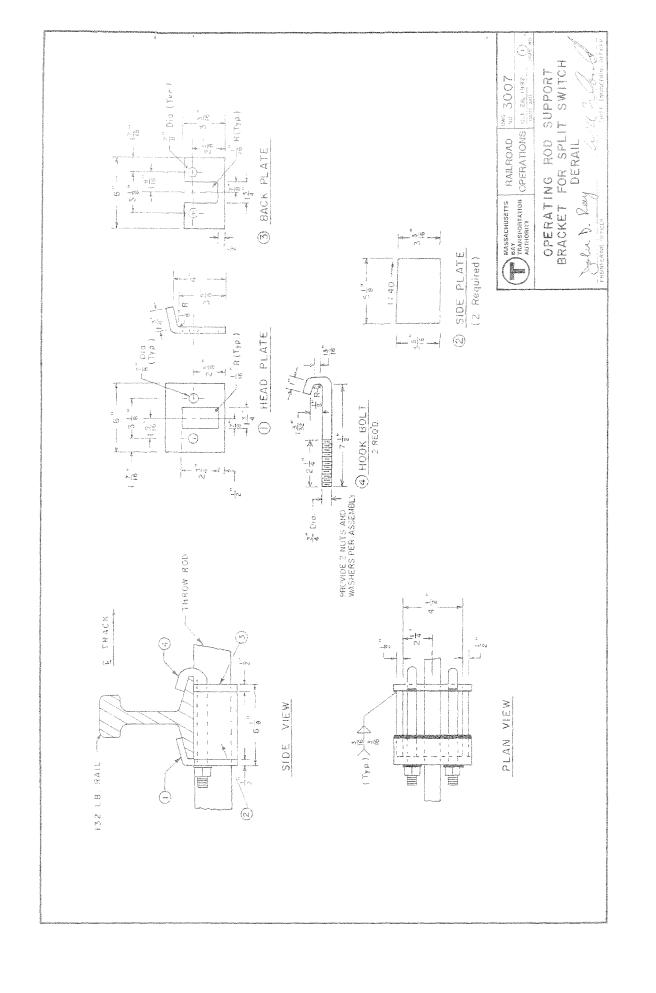
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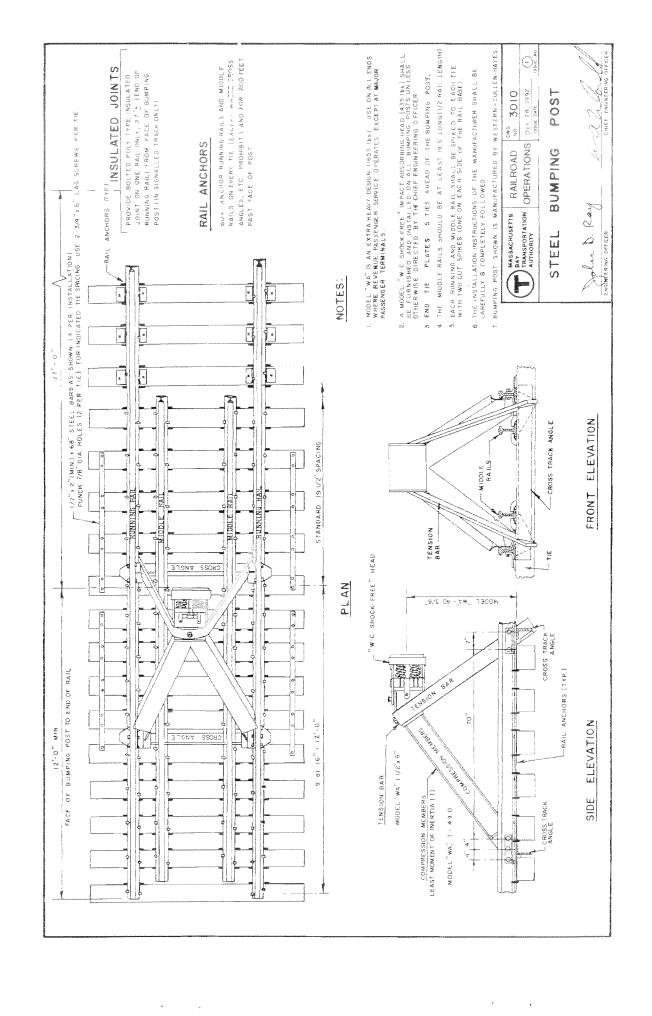


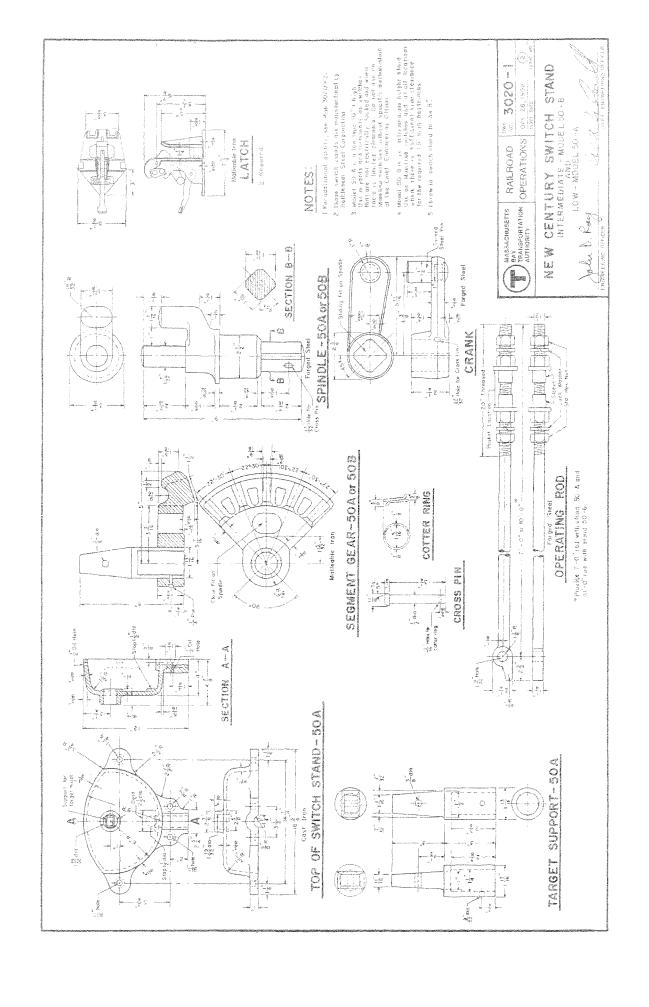
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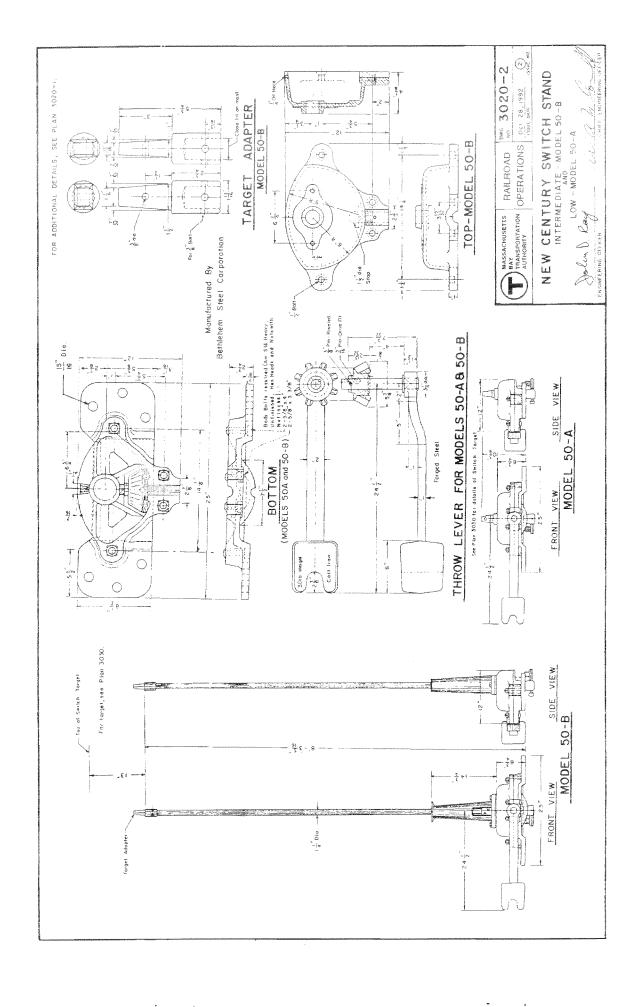
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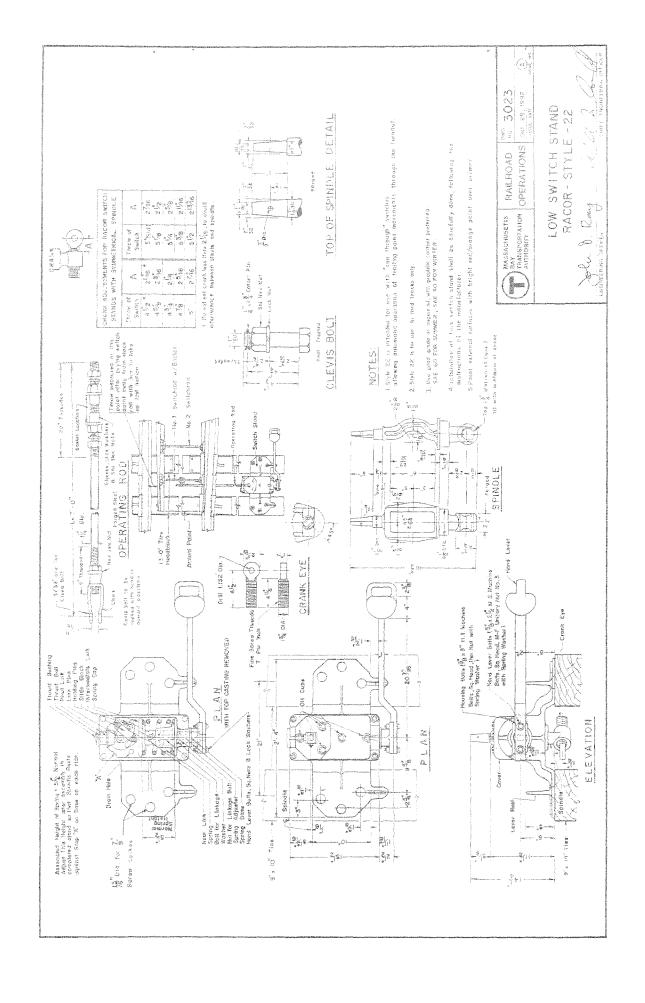


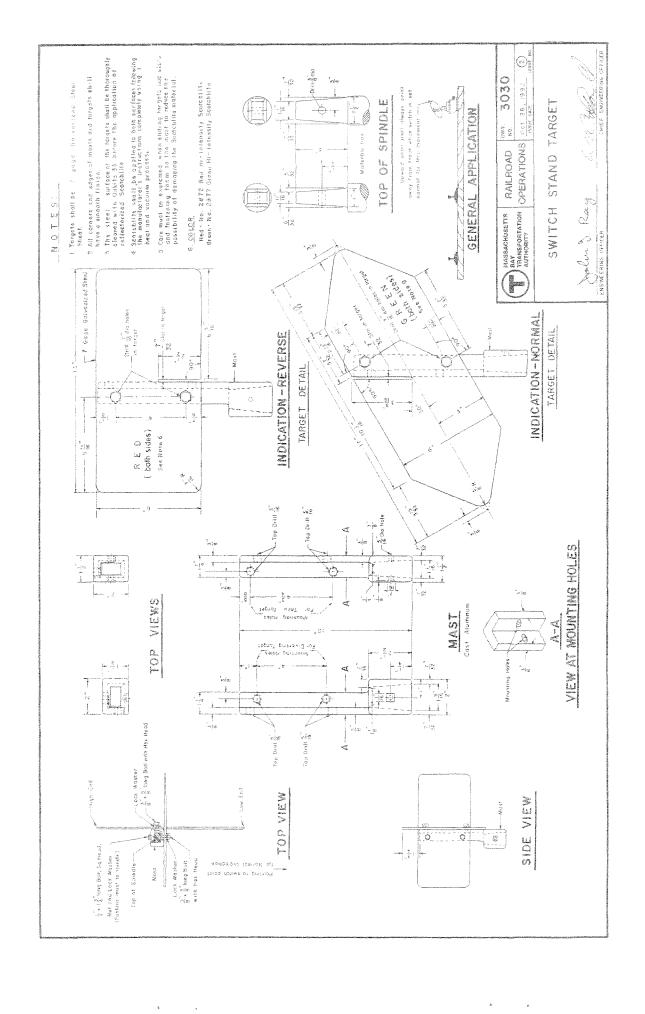


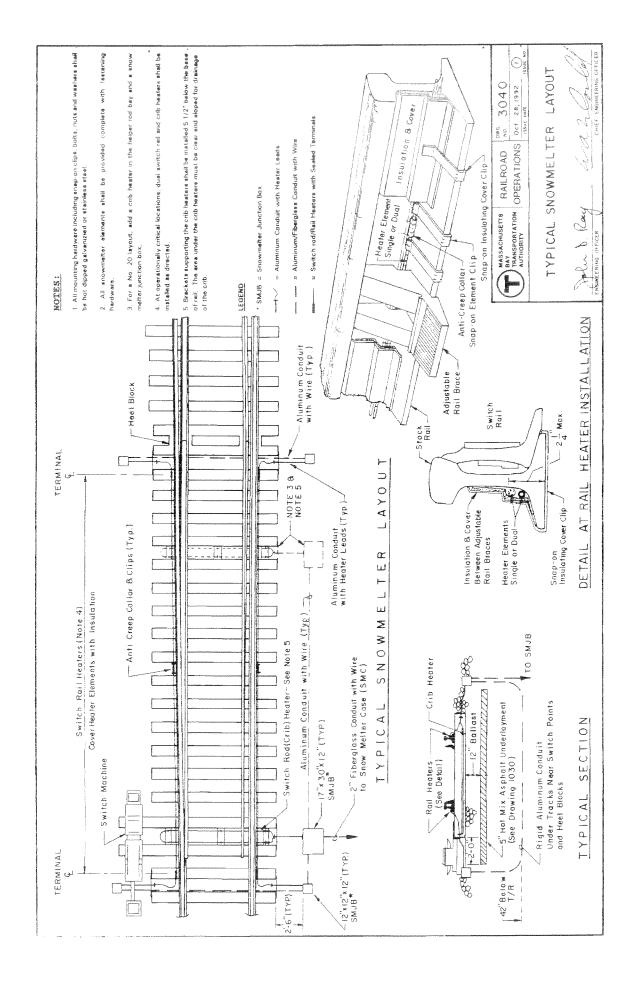


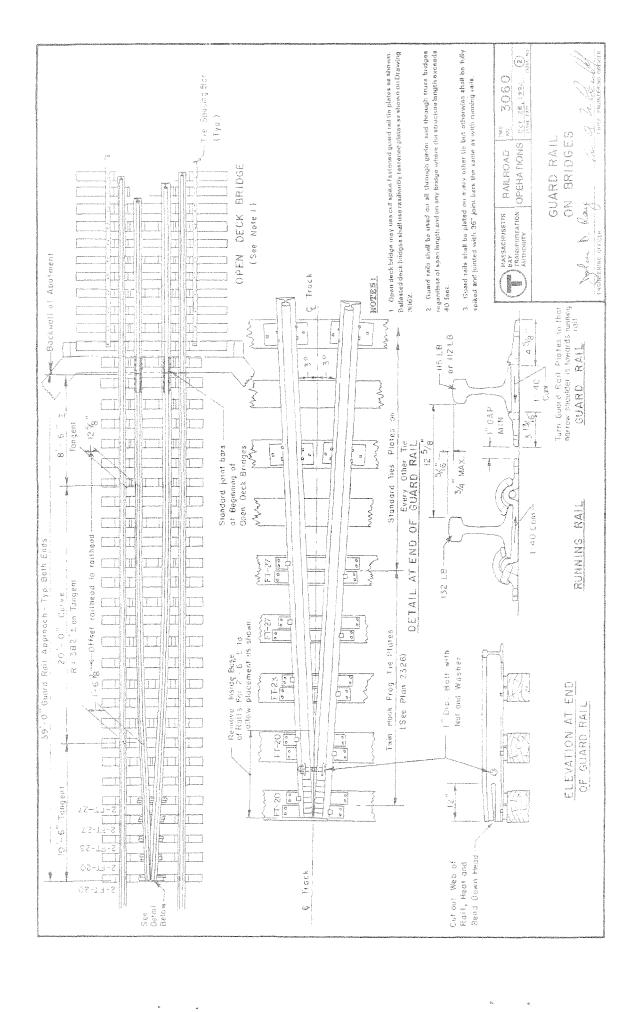


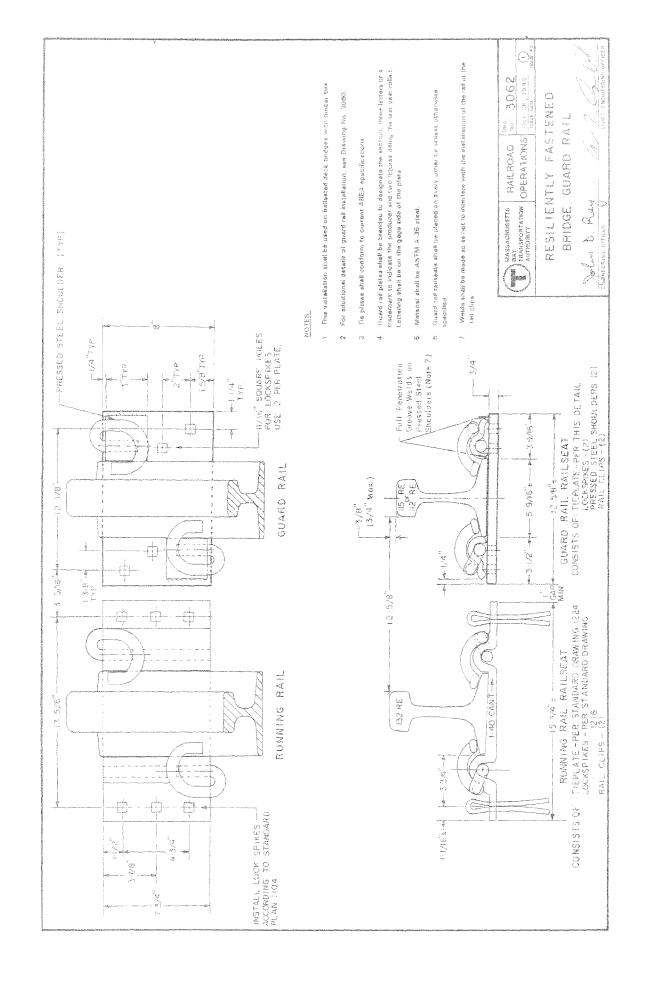


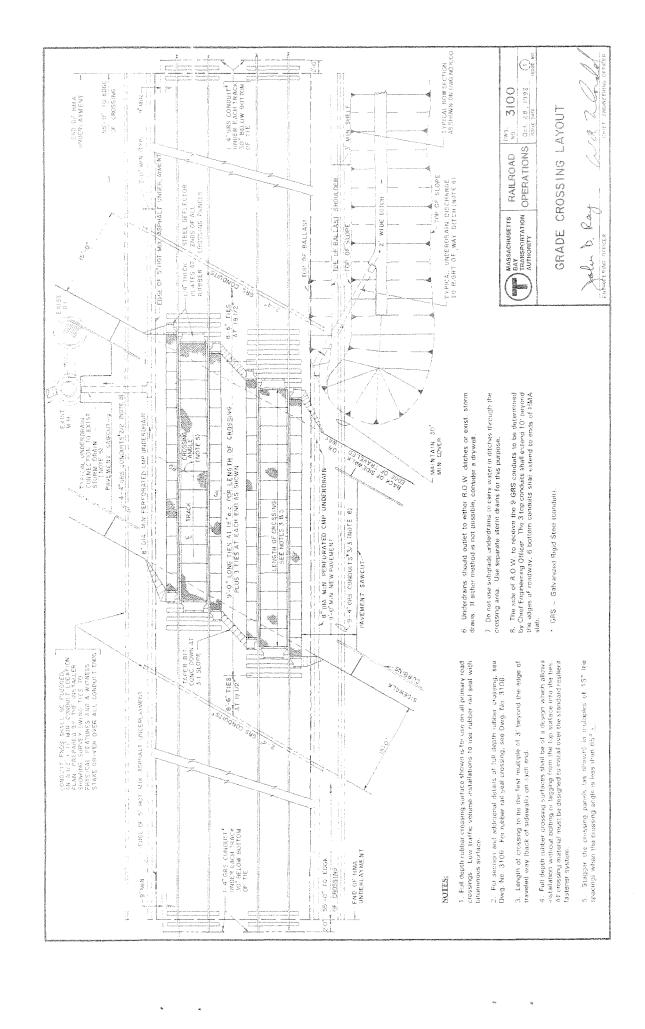


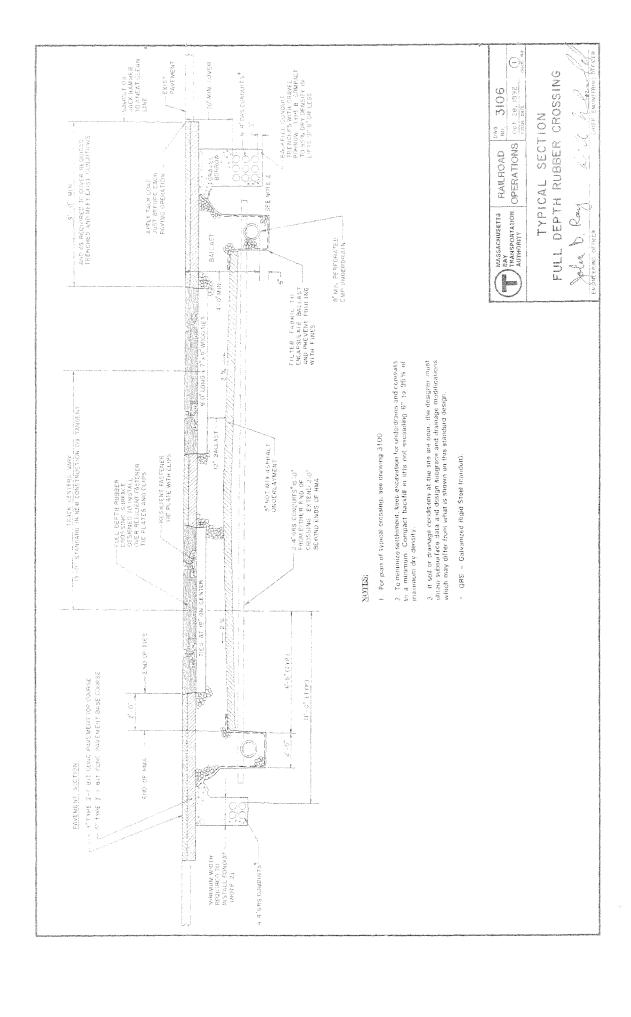


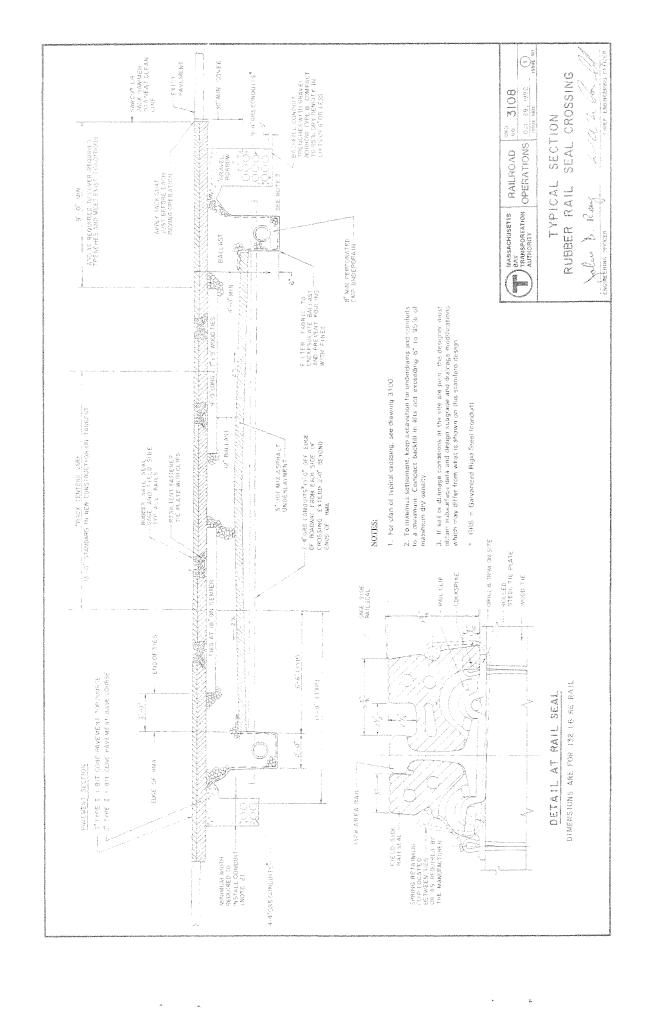


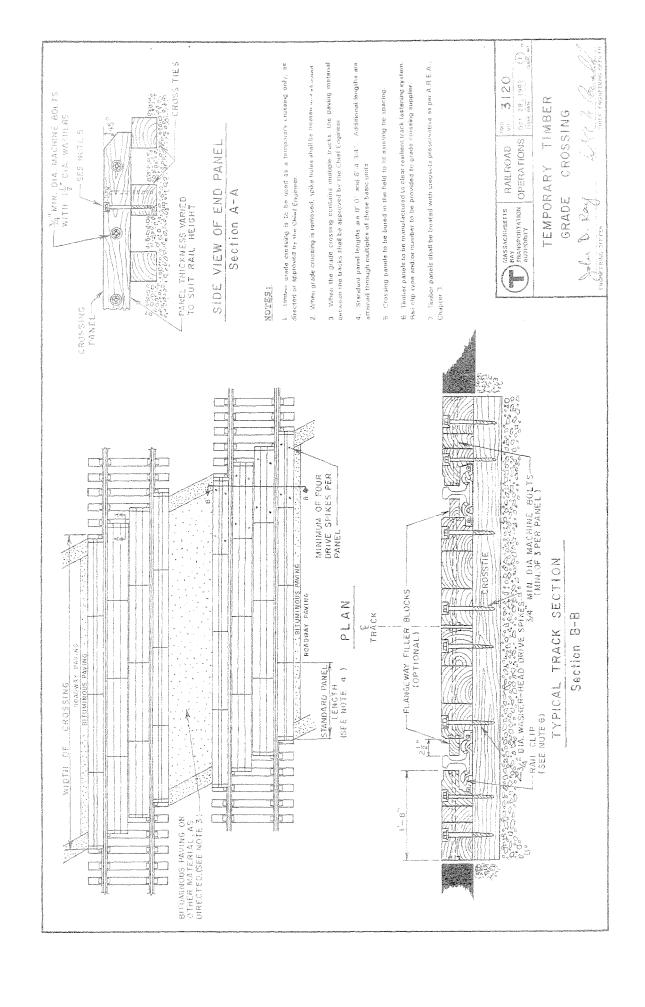


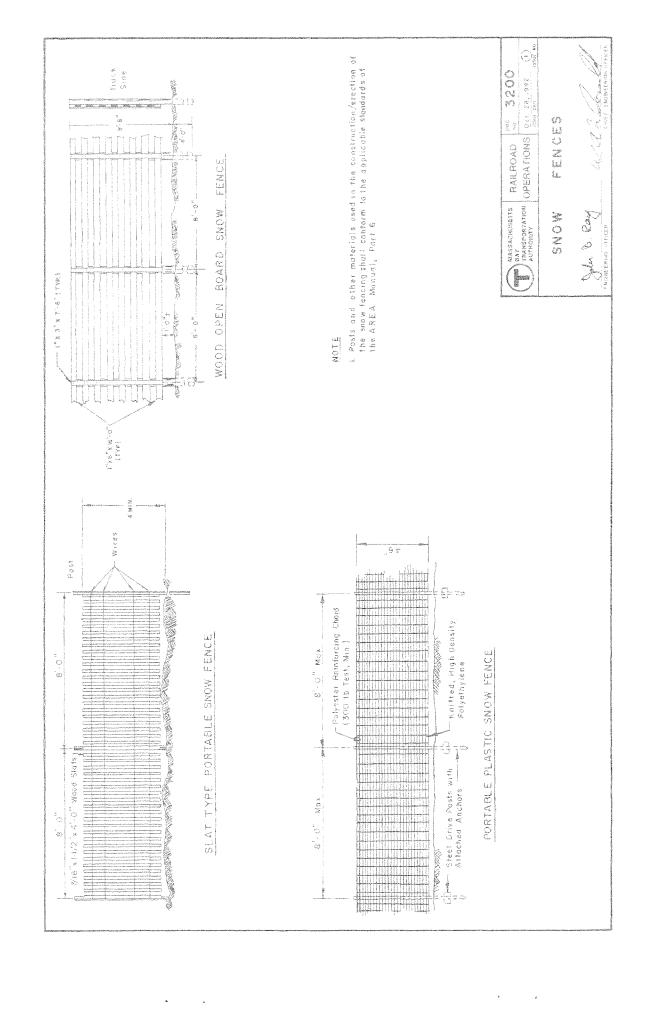


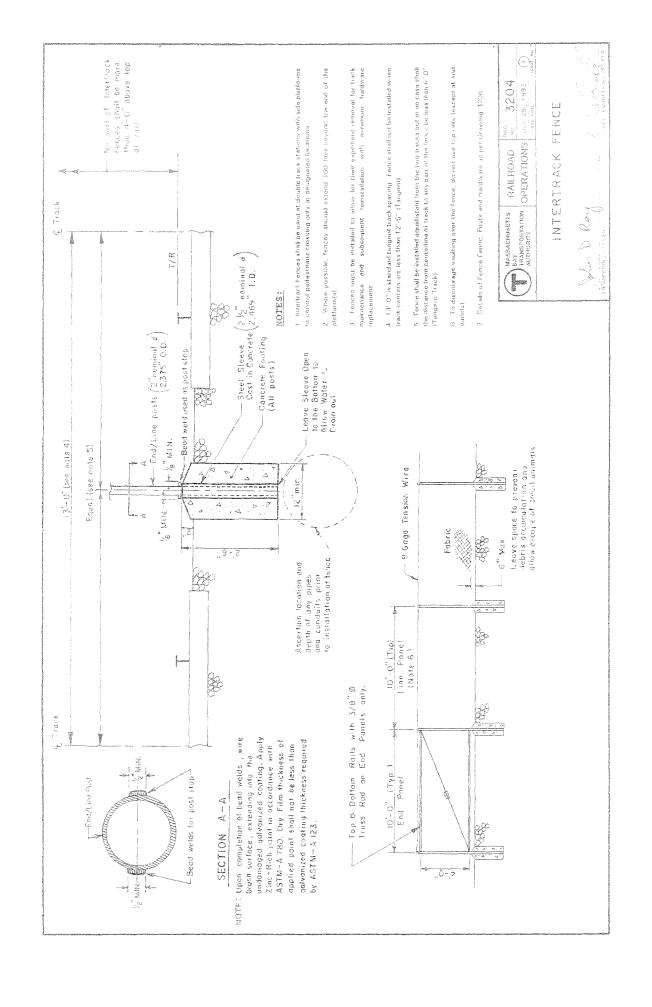


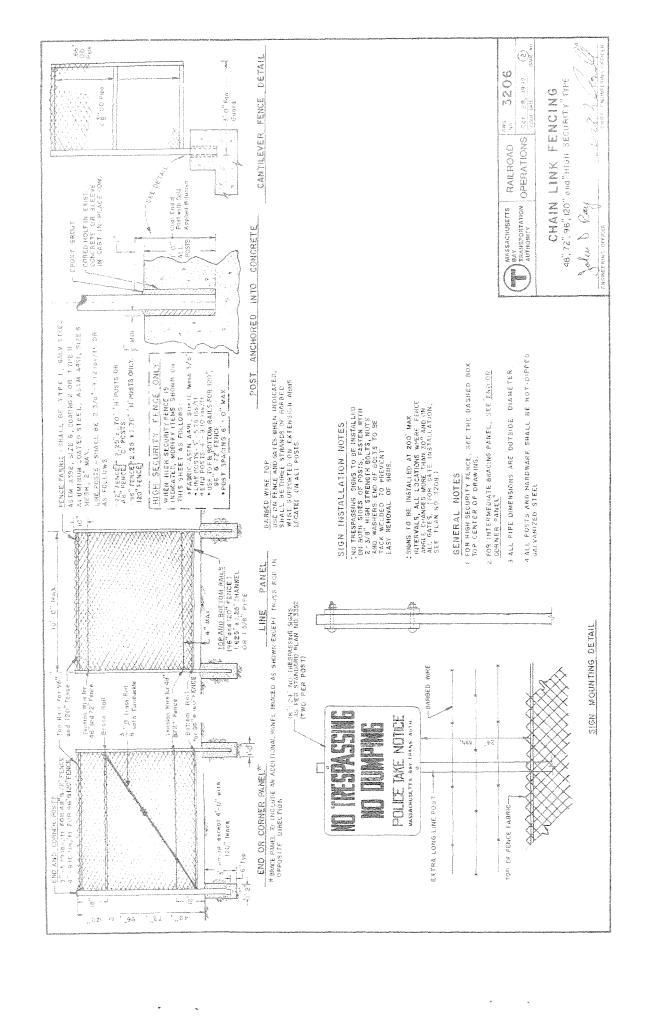


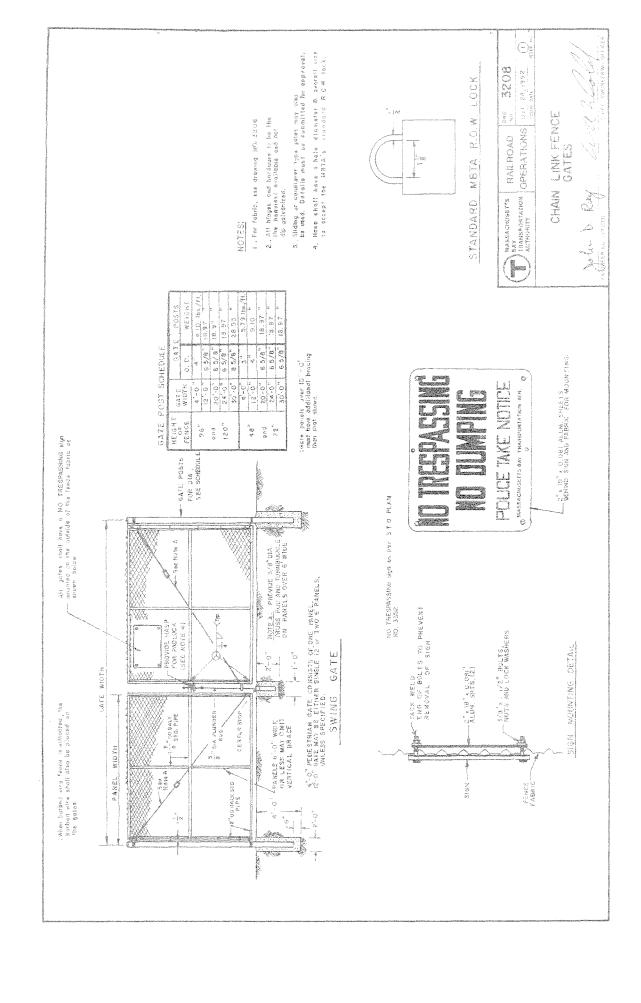


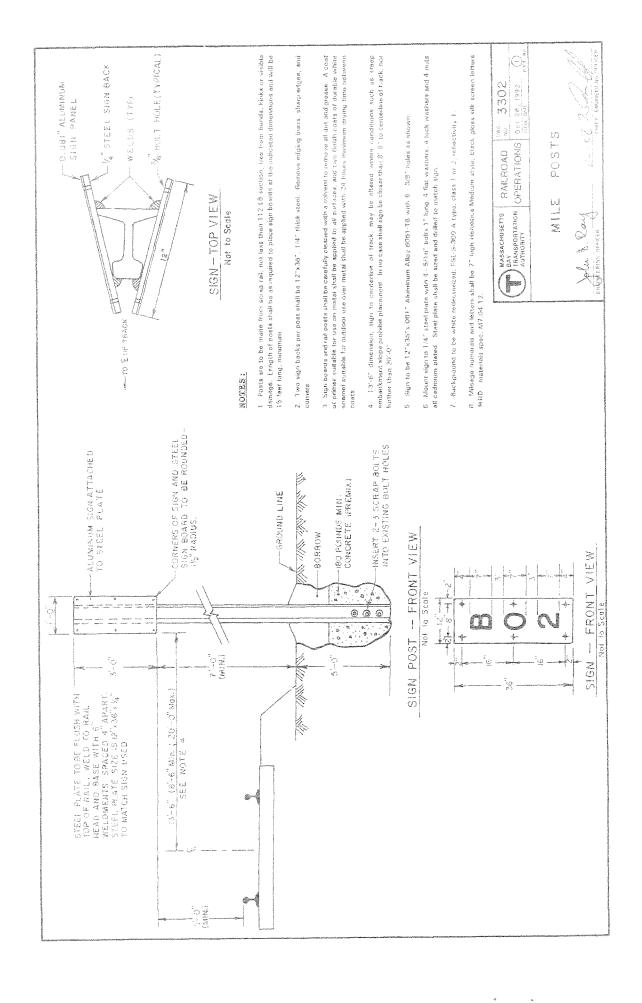


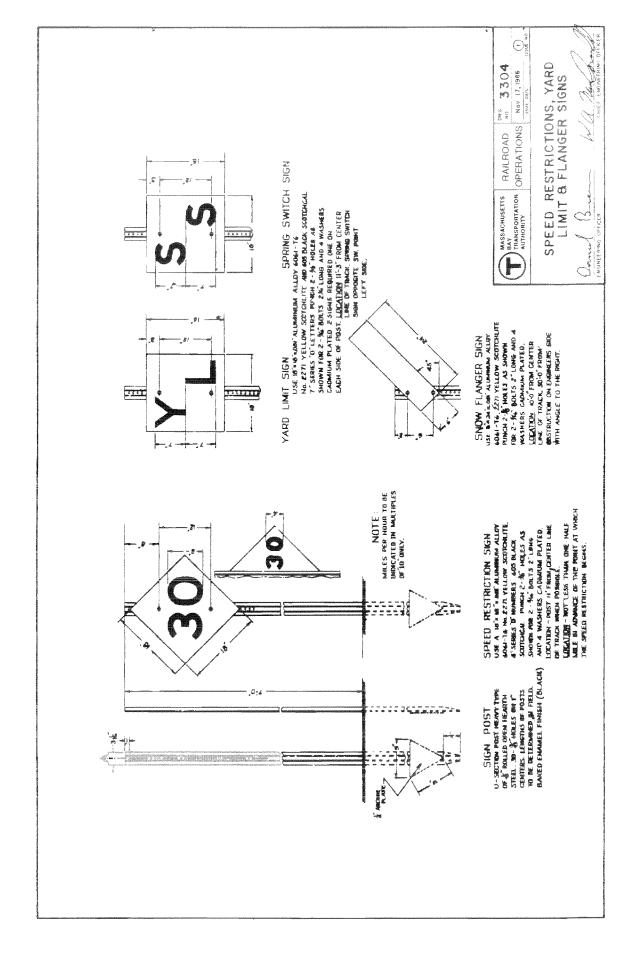


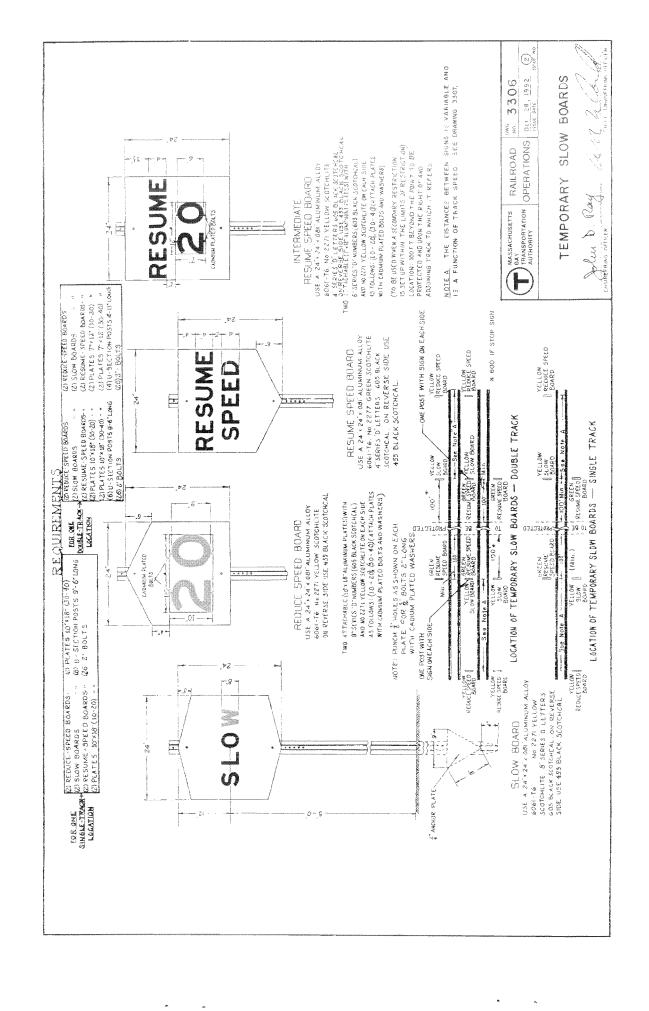












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if for descending grades in percent, increase distances above as follows.

0.37% to 0.66%-20% 0.11% to 0.35% 10% 0.67% to 0.92% - 30% Level to 0.10 % - NONE

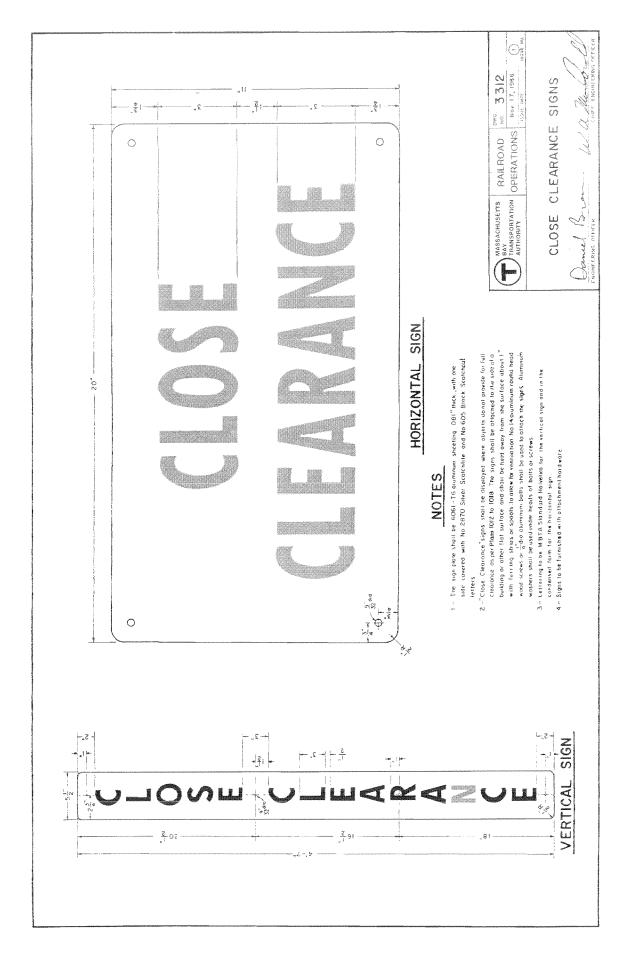
134 % 10 1.50 % - 60 % 1.51% to 164% - 70% 1.15% to 1.33% 50% 0.93% 101.14% - 40%

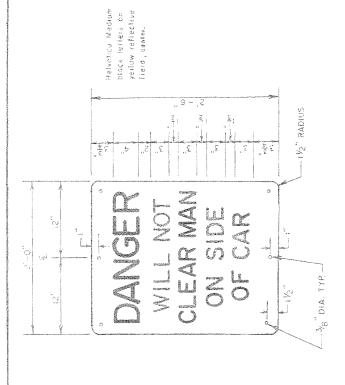
1.65% 101.78% - 80% 179% to 190% - 90% 191% to 2 00% - 100% 2.01% to 2.10% - 110% NOTE; See Brawing NO. 3306 for sign datolt and placement.

MASSACHUSETTS RAILROAD No. 3307
TRANSPORTATION OPERATIONS CO. 28, 1992
AUTHORITY

TABLE OF SLOW BOARD PLACEMENT DISTANCES

Scale D. Ray





CLEARANCE WARNING SIGN

- Signs to be 0.08i" thick aluminum alley sheet, ASTM B 209.
- Black gloss silk letters MHD materials spac. M7.04,12.

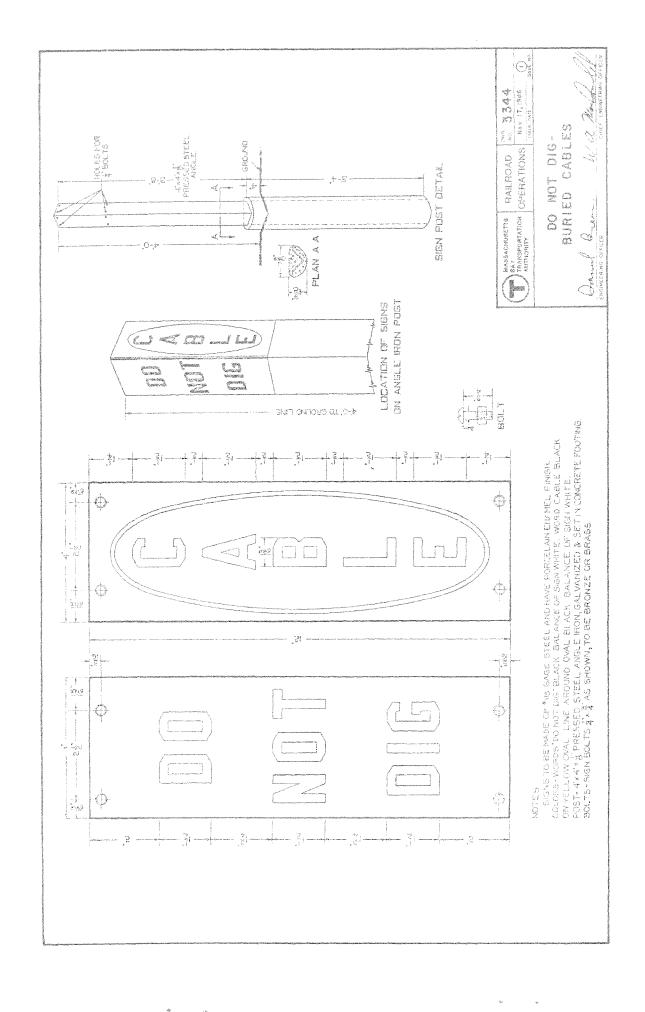
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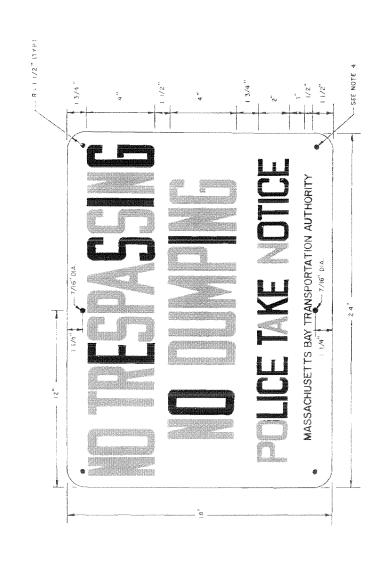
- Free standing signs shall be mounted on steel "V" shaped posts. Signs attached to structures shall be attached using threaded inserts.
 - All signs shall have six notes drilled to atlaw mensting on either posts or stractures.



CL.EARANCE WARNING

<u>S</u> <u>S</u> S 300





NO TRESPASSING SIGN

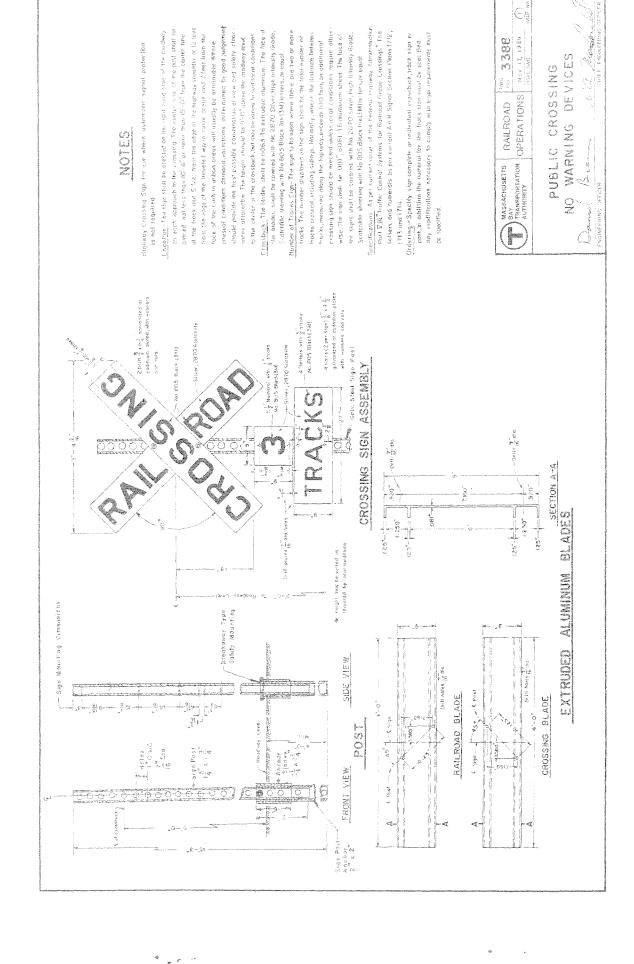
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- Black gloss silk screen latters, M.H.D. moterials, spec. M.7., 04, 12

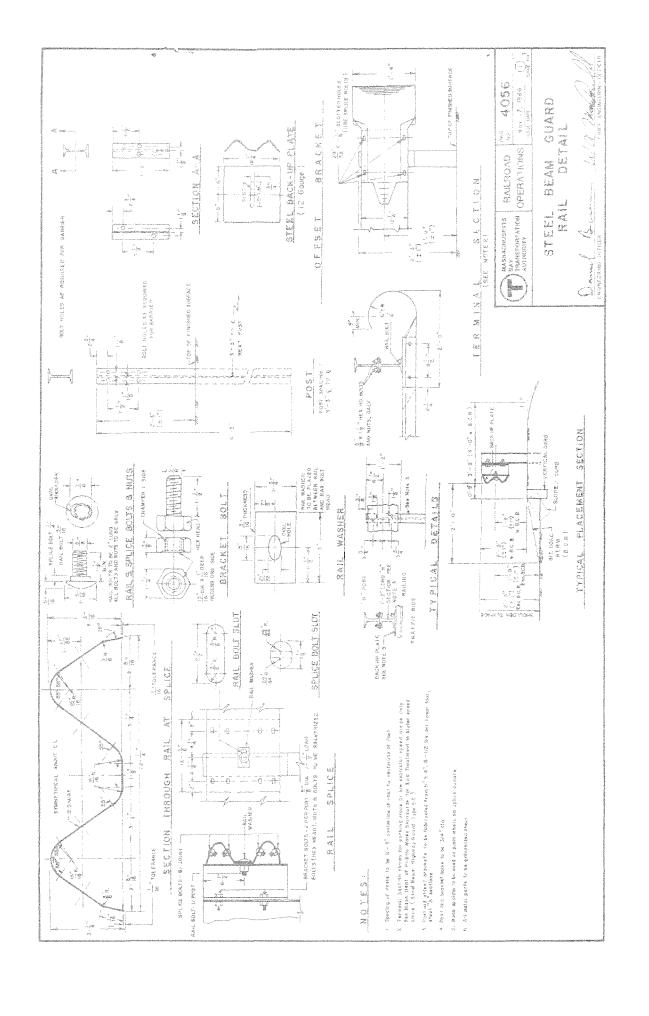
NOTES:

- I. Free standing signs not attached to feaces to be mounted on steel "U" shaped posts.
- 2. Place signs on both sides of right of way facting back towards highway grade crossing, at end of station platforms and at any location where trespassing is a problem.
- 3. Place on ROW fences at intervals not exceeding 200° (see Dwg. No 3206) and on oil gates (see Dwg. No 3207).
- 4. All signs shall have six holes drilled to allow mounting on either posts or fence fabric.

MASSACHUSETTS RAILROAD NG 3352
THANSACHUSETTO OPERATIONS CEL 28, 1992

NO TRESPASSING SIGN





APPENDIX G

MBTA - ENSURING ACCESSIBILITY DURING MASS DIVERSIONS



Massachusetts Bay Transportation Authority

SUBJECT: Accessible Mass Diversions	AFFECTED PERSONNEL: Ops, D&C, E&M, SWA	STATUS & DATE: Final 1-9-12
DOCUMENT #:	ISSUED BY:	SUPERCEDES:
SWA 01-2012	System-Wide Accessibility	N/A

Ensuring Accessibility During Mass Diversions

1.0 Purpose

This MBTA policy outlines criteria that must be fulfilled when designing and implementing a diversion within the Heavy Rail, Light Rail, and Commuter Rail system to ensure the service is accessible to customers with disabilities.

The MBTA/BCIL settlement agreement (2006), in additional to Federal and State law (including the ADA of 1990) require the MBTA to ensure that all diversions of service affecting customers are accessible to customers with disabilities. Specifically, that diversions are to be considered extensions of the fixed-route system and that customers with disabilities must be able to utilize the same alternate service as other customers and not be subject to segregation or to any disparate service or treatment. As such, the following policy addresses what criteria must be met when designing and implementing a diversion to ensure that all legal requirements are fulfilled.

2.0 Definitions

- 2.1 <u>Alternative Transportation</u>: Any transportation service used to temporarily replace or supplement existing MBTA fixed-route service due to a disruption or diversion
- 2.2 Shuttle Bus: Buses used to transport customers from one location to another
- 2.3 <u>Dual-Mode Communication</u>: The practice of broadcasting information both audibly and visually. This practice, required by law, helps to ensure that all customers are afforded access to information (e.g. customers who are Blind or low vision can access the information audibly, and customers who are Deaf or hard of hearing can access the information visually.)
- **2.4** <u>Accessible Station:</u> Stations accessible to customers with disabilities, including those using wheeled mobility devices
- **2.5** <u>Planned Diversion:</u> A change in routing of service necessitated by an anticipated event (e.g. preventative maintenance work, construction, etc.). Alternative service plans are developed in advance of need

- 2.6 Emergency Diversion: A change in routing of service necessitated by an unexpected event (e.g. signal failure, fire, etc.). Standard operating procedures pertaining to the scenario do not exist and Iternative service plans are developed for immediate use
- 2.7 <u>Undefined Terms</u>. The meaning of terms not specifically defined in this section shall be as defined by collegiate dictionaries in the sense that the context implies

3.0 Scope

The scope of this policy defines the design and implementation of a diversion within the Heavy Rail, Light Rail and Commuter Rail system that ensures accessibility to customers with disabilities.

4.0 Responsibilities

All Operations personnel shall be responsible for adherence to this policy. Additionally Design & Construction and Engineering & Maintenance, when tasked with procuring a shuttle, shall adhere to this policy. The Department of System-Wide Accessibility shall be available to provide clarification on any part of the policy, as necessary.

5.0 Policy

- **5.1** Shuttle Bus Service Requirements
 - **5.1.1** Any and all buses used to shuttle passengers as part of a diversion shall be accessible to customers with disabilities, including those who use wheeled mobility devices.
 - **5.1.2** Shuttle bus Operators shall adhere to the same requirements regarding accessibility as are in place in the standard fixed-route system. Including but not limited to:
 - 5.1.2.1 All wheeled mobility devices shall be properly secured
 - 5.1.2.2 All stop and destination announcements shall be made
 - 5.1.2.3 Customers with disabilities shall be assisted finding priority seating, upon request

Policy Location:	SUBJECT:		DATE:		Page 2 of 9
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REVIEWED BY:	Operations	Safety	Design &	Engineering	System-Wide
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DATE:	X/M 2-12	1-10-12	1.17.10	2/3/12	2-3-12
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5.2 Routing of Alternative Service

5.2.1 During a planned diversion of service, alternative service shall not terminate at an inaccessible station (see attached for list of inaccessible stations). This will ensure that customers with disabilities are still able to enter the MBTA system in the event that the station they had intended using to board/alight is closed and/or unavailable.

Exception:

- 5.2.1.1 When the station that is closed is inaccessible (e.g. if Wollaston Station is closed, a bus shuttle will be permitted to board/alight passengers at Wollaston).
- 5.2.2 During an emergency diversion of service, alternative service shall not terminate at an inaccessible station (see attached for list of inaccessible stations). This will ensure that customers with disabilities are still able to enter the MBTA system in the event that the station they had intended use to board/alight is closed and/or unavailable.

Exceptions:

- 5.2.2.1 When the station that is closed is inaccessible (eg. if Wollaston Station is closed, a bus shuttle will be permitted to board/alight passengers at Wollaston).
- 5.2.2.2 When routing all passengers to an accessible station places an undue burden on operational resources.
 - 5.2.2.2.1 If a diversion must terminate at an inaccessible station due to reason stated in 5.2.2.2, justification shall be documented and shared with internal stakeholders.
 - 5.2.2.2.2 If an alternative service plan includes terminating at an inaccessible station due to a specific reason referenced in 5.2.2.2, accessible shuttle service must be made available to customers with disabilities from the inaccessible station to the nearest accessible station on the affected service line.

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REVIEWED BY:	Operations	Safety	Design &	Engineering	System-Wide	
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5.2.2.3 Information regarding the *additional* shuttle must be included in any and all announcements made regarding the general alternative service plan.

Example: "Shuttle buses will replace Green Line service between Kenmore Station and Babcock Street on the B branch. Outbound customers who require accessible service will be shuttled to Harvard Avenue Station. Inbound customers who require accessible service should exit at Harvard Avenue Station where staff will assist."

5.2.3 The path of travel from this boarding/alighting location to the station's accessible entrance shall be accessible to customers with disabilities, including those who use wheeled mobility devices. The path should be at least three feet wide and free of obstacles.

5.3 Placement of MBTA personnel

- 5.3.1 MBTA personnel shall be posted at both ends of a service disruption to manage the shuttle and to provide assistance to customers, including those with disabilities, upon request. This may include assisting customers to/from the shuttle to/from the station's accessible entrance.
- **5.4** Communication of Alternative Service Information:
 - **5.4.1** Information regarding alternative transportation provided by the MBTA shall be broadcast in multiple venues including, but not limited to: press releases, MBTA website, T-ALERTS, at MBTA stations, and on MBTA vehicles.
 - **5.4.1.1** To avoid confusion, message content should be essentially the same in all broadcast venues.
 - 5.4.2 Information shall be presented in dual mode (audibly and visually). For example, audio/visual announcements should be broadcast using PA/VMS boards. If PA/VMS boards are not available, signs should be posted and announcements made. This will help to ensure that customers who are Blind or have low vision can access the information audibly, and customers who are Deaf or hard of hearing can access the information visually.

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DATE:	33-0	1-10-12	1.17.12	2/3/12	2-3-12

5.4.3 Information regarding alternative service shall be made at each station along the affected service line (e.g. If Revere Beach Station is closed, information regarding the closure and alternative service shall be broadcast at each station on the Blue Line). Likewise, information shall be broadcast on every subway train, at each stop along the affected line.

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DATE:	2/3/2	1-12-12	1.17.12	2/3/12	703-17

6.0 Attachments

- **6.1** MBTA/BCIL Settlement Terms Related to Providing Accessible Service During Diversions
- 22. Trains (subway and light rail) must be operated in a manner that makes them readily accessible and usable by persons with disabilities. Proper operation includes, but is not limited to, following official MBTA procedures in:
- o. assisting with obtaining appropriate alternative transportation when required.
- 31. The MBTA shall develop detailed procedures governing the provision of, and shall provide, alternative transportation services for passengers forced to detour because of failure of any piece of accessibility related equipment aboard any rail vehicle or at any rail station which results in the inaccessibility of an otherwise accessible station in accordance with the requirements of 49 C.F.R. § 37.161(b).
- 71. The MBTA must establish and operate a system to provide assistance to customers with disabilities. Customer assistance services must be available at all stations on the fixed route system. Customer assistance services must include a means of providing help with boarding or leaving trains and buses, using accessibility features, arranging for alternative transportation when necessary, and other assistance to facilitate use of the system by persons with disabilities. The MBTA must ensure that customer assistance services are available to persons with disabilities during all hours of operation.
- 72. The MBTA must provide alternative transportation to persons with disabilities when the fixed route system is not readily accessible or usable, in accordance with applicable ADA regulations. The system for providing alternative transportation must be designed and managed in a manner that ensures that customers are promptly advised of their right to alternative transportation, that the need for such services is promptly communicated to the responsible officials, and that services are provided in a timely manner.
- 73. The MBTA must have vehicles suitable for providing alternative transportation for persons with disabilities immediately available whenever there is a need to provide alternative transportation.
- 74. In any case where there is a planned or evident long-term situation when the fixed route system is not readily accessible or usable, the MBTA must establish, publicize and provide a dedicated ready means of alternative transportation to mitigate such an interruption.

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http:/intranet	Accessible Div	ersions	1-9-12				
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6.2 Inaccessible Stations within MBTA System (as of 11/20/11)

Orange Line:

All stations are accessible

Red Line:

Wollaston

Blue Line:

Government Center

Green Line:

- Government Center
- Boylston
- Hynes Convention Center
- B Branch
 - Blanford Street
 - o BU West
 - o St. Paul Street
 - o Pleasant Street
 - Babcock Street
 - o Packards Corner
 - o Griggs Street/Long Avenue
 - Allston Street
 - Warren Street
 - Sutherland Street
 - o Chiswick Road
 - o Chestnut Hill Avenue
 - South Street

- C Branch
 - Hawes Street
 - o Kent Street
 - o St. Paul Street
 - o Summit Avenue
 - o Brandon Hall
 - o Fairbanks
 - Tappen Street
 - o Dean Road
 - o Englewood Avenue
- D Branch
 - o Beaconsfield Station
 - o Chestnut Hill
 - o Eliot
 - o Waban
- E Branch
 - o Symphony
 - o Fenwood Road
 - o Mission Park
 - o Riverway
 - o Back of the Hill

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DATE:	2-3-12	1-10-12	1.4.1	2/3/12	2-3-10	

Commuter Rail:

- Worcester/Framingham
 - o Natick
 - Wellesley Square
 - Wellesley Hills
 - Wellesley Farms
 - o Auburndale
 - West Newton
 - o Newtonville
- Needham
 - o All stations are accessible
- Franklin
 - o Franklin/Dean College
 - o Walpole
 - o Plimptonville
 - Windsor Gardens
 - o Islington
 - o Endicott
- Fairmount
 - o All stations are accessible
- Stoughton
 - All stations are accessible
- Providence/Attleboro
 - Mansfield
 - o Sharon
- Middleboro/Lakeville
 - All stations are accessible
- Plymouth/Kingston
 - All stations are accessible
- Greenbush
 - o All stations are accessible

- Newburyport/Rockport
 - o Prides Crossing
 - o Riverworks
 - o Chelsea
- Haverhill/Reading
 - o North Willmington
 - o Wakefield
 - o Greenwood
 - o Melrose Cedar Park
 - o Wyoming Hill
- Lowell
 - o Winchester Center
 - o Wedgemere
 - West Medford
- Fitchburg
 - o Shirley
 - o Aver
 - o Littleton/495
 - South Acton
 - o Concord
 - o Lincoln
 - o Silver Hill
 - Hastings
 - o Kendal Green
 - Waverly
 - o Belmont

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REVIEWED BY:	Operations	Safety	Design &	Engineering	System-Wide		
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7.0 Signatures

Sean McCarthy
Chief Operating Officer

Ed Hunter Acting AGM, Design & Construction

Molarky

Ron Nickle \(\)
Chief Safety Officer

Laura Brelsford

Deputy Director, System-Wide

Accessibility

MIKE TURGOTTE

Mike Turcotte

AGM, Engineering & Maintenance

Effective: 2/3/12

Policy Location: http:/intranet	SUBJECT: Accessible Div	ersions	DATE : 1-9-12		Page 9 of 9
REVIEWED BY:	Operations 2	Safety	Design & Construction	Engineering 57 & Maintenance	System-Wide Accessibility
DATE:	2313	41-10-12	1:17:12	2/3/12	2.3.0